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VIEWS, NEWS AND INTERVIEWS.

The managing committee of the Frankfort Electrical Exhibition has made the following announcement:

"The Grand Duke of Weimar has graciously placed at the disposal of the committee the electrical machine with which Goetbe made his experiments. This machine is at present located in the Goethe Museum at Weimar, and will be placed in the Hall of Medicine and Science.

"The work at the exhibition, both in the grounds and in the various buildings, is being carried on with feverish activity, and the progress is really marvelous."

Prof. Elihu Thomson wears a unique watch chain, the links of which are welded by electricity. In part of the chain links of gold and platinum alternate. Other links are made of sections of these metals.

Attorney-General Smith, of Indiana, has given his opinion that the franchises of street railways, electric light companies, gas companies, water works and so on, are taxable. Heretofore only the visible property of such companies has been taxed.

The electric railway between St. Paul and Minneapolis is a government mail route. The electric cars carry the mails so that deliveries are made in each city every two hours. Needless to say, the plan meets with the appreciation of the citizens.

The result of the great horse race at Epsom Downs, England, was cabled from the track to the New York newspaper offices in just 53 seconds.

Every one has noticed the advertising signboards which parallel the principal lines of railroad. How many people have seen these signs at night? Here is an opportunity for somebody to invent an automatic electrically illuminated sign which will light up at dark and unlight at daybreak.

Chauncey M. Depew, discussing the plans of the New York Rapid Transit Commission, said:

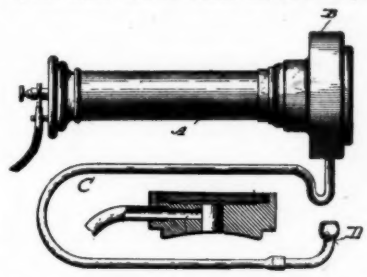
"I do not know of any motive power at present, other than steam, that will draw a loaded train at a rate of 20 miles in 40 minutes. I have great faith, however, in electricity. Such marvelous results have been shown by experiments that I wouldn't be surprised at anything that might come of it."

Professor Wiggins, the weather sharp, says he expects a dry Summer this year, and attributes it to the increased use of electricity in towns and the use of wire fences in the country, thus keeping away the thunderstorms.

Among the first Thomson electric welding machines used were two set up in a blacksmith shop. The welder was placed in charge of two boys, who turned out axle welds with great regularity. An old smith walked up to the machine and watched it for some time. "To think," said he, turning away, "that these here two boys can make just as good a weld with that contrivance as we who have served an apprenticeship and worked 20 years at the trade."

Dickson's Telephone.

Users of the telephone are greatly disturbed by outside noises, a trouble principally due to one ear only being covered by the receiver. Mr. Chas. T. Dickson presents a device illustrated in the accompanying engraving designed to overcome the disturbance. An opening in the side wall of the sound chamber of the receiver is fitted with a tube over which is slipped one end of a flexible tube C, the other end of which has an ear tip.



On ordinary occasions the receiver is used in the regular way, the tube C then hanging free or being coiled about the handle. If the listener is disturbed by outside noises, the tip D is inserted in the other ear, thus excluding the local noise and providing for the conveyance of the sound waves to both ears.

A Proposed Thomson-Houston Steamship Line.

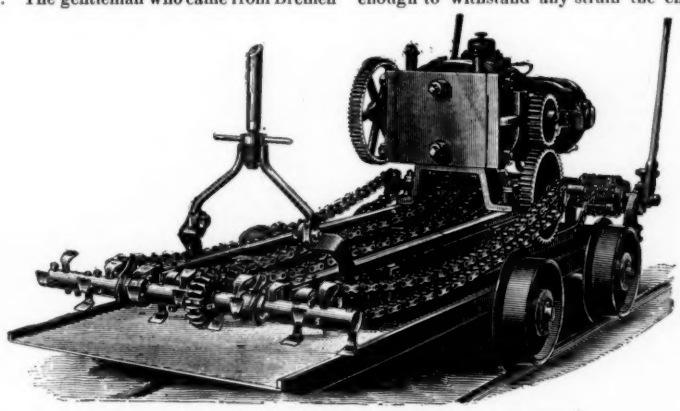
Mr. L. J. Magee, who visited the Thomson-Houston factories at Lynn, Mass., last week, is endeavoring to form a German company to take the International Company's patents. He had with him capitalists from Cologne, Berlin and Bremen. More of the products of the Thomson-Houston Company are sold in Germany than in any other foreign country. The gentleman who came from Bremen is the attorney of the North German Lloyd Steamship Line and also a member of its board of directors. Those interested in the electric company urge upon him the importance of establishing a line of the German Lloyd steamers from Boston to Bremen, touching at Southampton. Such a line would not only be very popular from the standpoint of passengers who now go to New York in many cases, but would prove a very great convenience for freighting, giving the Thomson-Houston Company the advantages of the free front of Hamburg. The International Thomson-Houston Electric Company is now compelled to keep a man at New York all the time to watch shipments and prevent breakages and other accidents.

The Edison General Electric Company's Coal Cutter.

The coal cutter adopted by the Edison General Electric Company is of the cutter bar type, has been in use for several years, and has been thoroughly tested. This machine, which is illustrated herewith, has the advantage of great strength, and excels in design and distribution of material to give the necessary strength and rigidity. A special feature of this machine is that the cutter bar revolves in such a direction that the coal is cut in an upward direction. This method greatly assists the weight of the machine in holding it down to the ground, and to a great extent avoids the necessity of carefully fastening it by means of braces or jacks. It is evident that if these have to be applied tightly, the machine is in great danger of being warped out of shape, unless the floor upon which it rests is very even.

With machines using the cutter bar, the bearings holding this bar have necessarily to be very short, for otherwise the ridge of coal left standing in front of them, which cannot be reached by the cutters, would be too wide and strong to be readily broken away by the wedge shaped front of the bearing. It has been customary to make these bearings 1¼ inches wide, and to transmit the power to the cutter bar direct by means of a chain. In this manner the cutter bar has not only to withstand the strain due to the resistance of the coal being cut, but also that of the chain itself, which, when 15 horse-power are transmitted to the cutter bar, amounts to 3,600 pounds.

The Edison Company has adopted a countershaft behind the cutter bar, to which the power is transmitted directly from the motor by means of four chains. This countershaft has bearings six inches long, and strong enough to withstand any strain the chains may exert on them. To transmit the power from the countershaft to the cutter bar, gears are used with peculiarly shaped teeth, which prevent the coal dust from settling between them. The only strain on the cutter bar of the Edison Company's machine is due to the resistance of the coal. The superiority of this construction is evident, when it is considered that the bar is very much weakened by the number of holes drilled into it to receive the cutting tools and the set screws required to hold them. The cutter bar is already about as strong as it can well be made. Any increase in diameter would also increase the height of the cut, which already is four and one-half to five inches high.



Edison General Electric Company's Coal Cutter.

There are other advantages in the design of the machine used by the Edison Company which adapt it to withstand the rough usage to which it is subjected in mines. Among them can be named, simplicity in design of feeding devices, and the use of rollers for the sliding frame, which reduce to a minimum the friction between it and the stationary bed, and decreases the danger of binding between the two.

To determine the amount of power required for coal cutters, a number of tests were recently made with machines at work in coal of varying degrees of hardness. These tests have shown that a 15 horse-power motor is sufficient for the purpose. In some places the power required exceeded this amount, but as the machines only ran off and on, having their full load on for about four minutes at a time, a motor having the above-named capacity was found to be sufficient; and a careful examination of the condition of the armature and magnet of the machine showed them to be perfectly cool.

The motor used for the Edison General Electric Company's coal cutter is capable of giving 15 horse-power when doing steady work. When running off and on only, as would be the case when used with coal cutters, it is capable of giving by far larger power. This motor is especially well adapted to the work it has to perform; it runs entirely without sparking and has all its vital parts well protected. The insulation of the machine has been given especial attention, and in this respect the Edison Company has been greatly aided by its experience with the large number of its motors now running in mines and upon street cars.

The Edison Company builds coal cutters capable of making a cut four feet, five feet and six feet deep, by three and a half feet wide. All coal cutters are provided with a suitable truck, by means of which they can readily be moved from place to place. The devices on the truck to load and unload the machines are very simple and efficient, and each machine is supplied with a cable 150 feet in length, and provided with suitable devices to enable it to be readily attached to the main wires and detached from them.

The average cost of equipping a mine with the electric plant necessary for mining 400 tons per day in a five-foot vein of bit coal (the plant being operated 20 hours per day) would be about $9,500. This does not include steam engine, boilers and building.

Meeting of the Executive Committee of the National Electric Light Association.

A meeting of the executive committee of the National Electric Light Association will be held at Montreal, Canada, this week, to arrange details for the coming convention.

An active interest is being taken in the Montreal meeting, and it looks very much as though the attendance and objects of interest displayed will equal and even exceed those of former conventions. The popularity of this association has been growing with remarkable vigor during the past few years, until now the strength of the organization places it on a plane with the great societies, not only of this country, but of the world.

This is deservedly so, owing to the very practical nature of its objects and labors, and the immense aid it affords to its members in a knowledge of the most economical and efficient solution of the every-day problems arising in the course of commercial work.

The immense Victoria skating rink at Montreal will be used for the purposes of the exhibition, as it has been found that a smaller hall would not be sufficiently large to accommodate the many who are anxious to obtain space.

OUR CINCINNATI LETTER.

The Thomson-Houston Motor Company, of this city, are making a number of sales of the Crocker-Wheeler fan motors, and also of larger motors for power.

Post & Company have secured the contract for wiring the St. Nicholas Hotel, of this city. This is a new departure for this firm, and they have already secured some valuable contracts.

Mr. C. P. Woodworth, general agent at Indianapolis for the Central Thomson-Houston Company, reports business very good in his line, and also in the small fan motors which he is handling.

D. J. Hauss reports sales of a five horse-power 500 volt Edison motor to Julius Zesterman for running his factory for manufacturing jewelry trays, and also to Chas. Doerr & Sons one five horse-power Ohio Valley motor for running ice cream machines.

Mr. Wells Goodhue, representing the Electrical Supply Company, of Chicago, was in the city last week. He reports large sales of supplies and also of the Sunbeam lamp, which his company is putting on the market. They have placed over 100,000 of these lamps in service in less than a year.

Mr. Thos. Claufield. of Chicago, representing the Western Electric Company, is in the city, and has started the work of wiring the new City Hall. This is the largest contract for such work ever let in this city. Nothing but braided Okonite wire will be used, and it will be run in interior conduits.

The Cincinnati Street Railway Company have just finished stretching an additional feed wire along their Colerain avenue line. This company has done more towards the advancement of the electric railway than any other company in this vicinity. They use the Thomson-Houston Electric Company's double-trolley system.

The Atlas Engine Works, at Indianapolis, have a most complete electric light plant. It consists of two 50 light 2,000 candle-power dynamos, and 20 series incandescent lights. They use 100 sixteen hour arc lamps to light up their shops and yards. The two engines used in driving this plant are of their own manufacture, and are 10x12 inches self-contained automatic engines.

Cincinnati, June 2, 1891. E. S. M.

OUR CHICAGO LETTER.

Mr. G. T. Hewes, until recently superintendent of the Ironwood Electric Company, is in the city.

The Sperry Mining and Machinery Company report a very flattering demand for the many specialties they are introducing.

Mr. Edward La Selle, manager of the Southwestern Electrical Supply Company, spent a day or two in Chicago this week.

Cutter says that his orders for street hood and the well known Morris trolley hanger manufactured by him have been large this week.

The Mosher Arc Lamp Company have been obliged to increase their force, the demand for their lamp for incandescent circuits having grown so as to necessitate this move.

The Sale of the property, etc., of the Thwing Electric Company has been postponed until June the 8th. There is a prospect of the company again doing business.

Mr. R. D. Ecker, of the Citizens' District Telegraph Company, of Butte, Montana, has been in the city this week. His company intend in the near future to introduce a messenger system.

Mr. R. E. Gallegher, secretary of the New York Insulated Wire Company, is in the city. He is accompanied by Mrs. Gallegher, and will spend a few weeks in the city, combining some business with, we hope, a great deal of pleasure.

The Great Western Electrical Supply Company state that their new railway catalogue is in the hands of the printer and will be ready shortly for distribution. It is to be a comprehensive book, covering all the appliances needed in line and station equipment, as well as motor repair parts for all systems. Roads contemplating extensions will do well to send for it.

On Wednesday last the new restaurant of the Chicago Electric Club was thrown open to its members. The club now has a complete restaurant, modern in every particular, and with facilities suitable for any occasion. This is all due to the untiring efforts of Mr. W. B. Pearson, chairman of the House and Resident Committees who has devoted much valuable time to the bringing about this desirable change in the affairs of the club. It is now possible to secure anything from the lightest lunch to an elegant dinner, and without "delay," a trouble the club has always experienced. Suffice it to say, that Mr. Pearson and his committee have the hearty thanks of the club, and there is little doubt but that the boys will show their appreciation by putting in an appearance at lunch whenever possible. L. W. C.

Chicago, June 2, 1891.

The Eickemeyer Gearless Electric Locomotive.

Some months ago the REVIEW gave its readers a description of a street car operated on the Eickemeyer-Field system, the axles of the car being driven by a pitman, driven directly by the armature shaft of the motor, gearing being dispensed with. An illustration of a car equipped under the system was furnished with such details as were then afforded for publication, and further details were promised. Such details are now available. The facility with which the electric motor does its work under direct coupling, the absolute noiselessness, the low speed of the armature, are advantages which insure a leading place for this system in street railways, and indeed for interurban traffic, when a suitable system of energy supply renders such locomotion commercially practicable. With motors requiring high speed for their proper operation reducing gearing must be employed, and to that end toothed gearing—such as the worm, the beveled and plain types—have been largely used, also frictional gearings, as well as belting and driving chains, in each instance so organized as to impart to the driving-axle of the car or locomotive a much slower speed than that at which the armature is rotated. The practical value of an organization having direct pitman as compared with other electric locomotives is that all parts of the motor proper may be firmly mounted with relation to each other, and the motor can be freed from those rail-shocks which must result if any portion of the motor be also a portion of a driving axle or its wheels. The direct pitman connection also obviates a well-known and serious loss of power, necessarily involved in the use of toothed gearing. There are no such lost motion strains or "backlash" strains incident to the use of belting or chains during frequent stopping and starting, as in street car service, and the mechanism is smoother in its operation, as well as noiseless. To accomplish the results yielded by this system a special motor is used which involves but little weight in proportion to its power, and its armature can be effectively revolved at that comparatively slow speed at which the driving-wheels can be properly driven. This direct pitman connection is claimed to be the first which, while having requisite power under slow speed, involves such limited bulk in the motor that it can be safely located in the vertical space usually available between the under surface of an ordinary street car floor and the surface of the ground between the tracks. This characteristic is of very material consequence, because in new cars there need be no radical departures either in size of wheels or in methods of mounting the car body thereon, or in the construction of car bodies, their platforms and steps. This feature also enables the motor and frame, its driving-wheels and axle, and its direct pitman connections to be practically applied to ordinary street cars now in service and to retain intact on the car one pair of wheels and their axles, thus enabling changes from animal power to electrical with a minimum of expenditure in rolling stock. The Eickemeyer motor embodies essentially, an armature which has an iron core directly polarized by the field coil or coils and magnetic metal so disposed as a casing or shell with relation to said coils and to the armature that substantially all of the magnetic lines developed by the field coils must pass through some appropriate portions of the armature core, and most or all of said lines have their circuit within the magnetic metal casing. It is claimed that the armature cores are magnetized to complete saturation, limited in each case solely by the magnetic conductivity of the iron in the core, and for that reason the motors are much lighter and of much less bulk than other motors having a corresponding working power. This extraordinary concentration of the magnetic lines of force enables armatures not much, if any, larger than those heretofore used below a car floor, to operate at slow speed and with great power.

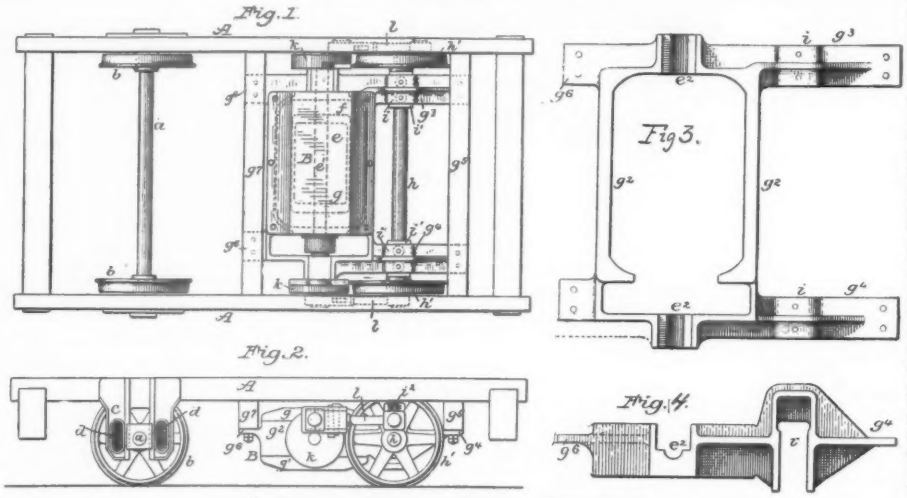
The main feature of the invention consists in the combination, with driving wheels and an axle, of a slow speed electric motor containing an armature having an iron core, field coils which surround and directly polarize the armature, and a shell or casing which surrounds the field coil and armature, springs which relieve the motor from shocks or strains imparted from the rails to the wheels and axles, and pitmen or links with cranks for directly connecting the motor shaft with the driving wheels or axles. Referring to the drawings, Fig. 1 illustrates in plan view a car floor frame mounted upon one ordinary axle and its wheels, and one driving axle and its wheels, the latter being directly connected by pitmen with the shaft of the motor. Fig. 2 illustrates the same in side view. Fig. 3, in plan view, illustrates the motor frame, including the central portion of the motor casing, with sides or arms and brackets for connection with the driving axle and car floor frame. Fig. 4 illustrates said frame in side view. Fig. 5, 6 and 7 in plan view, side elevation, and end view illustrate a street car motor as organized to operate on driving wheels smaller than those on the non-driven axle. Fig. 8 illustrates the method of spring mounting one end of the motor on the driving axle.

The motor frame is spring mounted at one end upon the driven axle while at the other end it is supported by the car floor frame. Such a motor frame connected with the driven axle constitutes in one sense a two wheeled truck, inasmuch as one end of a car is supported thereon; but for sustaining the end of the frame which embodies a part of the motor casing or shell, a rigid pendent connection with the car floor frame is essential. In Figs. 1 and 2, a car floor frame is indicated at A. An ordinary axle *a* and its wheels *b* are connected with the floor frame by means of the usual pedestals, box-jaws or journal box frame *c*, containing suitable car springs *d*. With outside pitman connections between the motor shaft and the driving wheels it is obvious that the car springs over the driving axle must be inside of the driving wheels. If all four wheels of a car be thus driven and all of the car springs are inside of the wheels, the lateral bearing or tread on the springs is so short as to cause the car to be so easily rocked as to render it objectionable, and hence it is well to have but one axle driven, and thereby retain the broad lateral tread afforded by outside springs on the undriven axle.

In Fig. 1 the motor B has its interior construction indicated in dotted lines. At *e* and e^1 is shown, the armature and its shaft and the field-coils at *f*. Said field-coils surround the armature, which having an iron core, is directly polarized by said coils. The armature and field-coils are well inclosed by an iron casing or shell, which affords a metallic circuit for substantially all of the magnetic lines of force developed by the field coils, and all of said lines pass through some portion of the core of the armature. With these parts of a motor thus organized extraordinarily effective magnetic conditions are developed by reason of a complete magnetic saturation of the iron core of the armature, resulting in high magnetic excitation with corresponding slow speed and efficiency.

The armature embodies a separate set of coils or windings previously formed and then assembled on the armature-core and secured to the latter at its ends by means of studs or pins, which afford lateral abutments for each of said coils, and with the usual banding at the periphery said studs render the core and winding a substantially solid structure.

The casing or shell of the motor has a cap-plate *g* and a bottom-plate g^1, both of which are bolted to and hence detachable from a central main or body portion g^2, thus affording convenient access to the armature and field-coils. This body or main portion g^2 of the casing is in two parts, each integral with and constituting a cross-beam in a "motor-frame," which affords bearings for the armature-shaft and has sides or arms g^3 g^4 projecting to any desired extent, so as to overlie a driven axle *h* inside of its driving-wheels h^1, and each of said arms has a jaw *i* for a journal box i^1 and springs i^2. The frame sides or arms g^3 g^4 are extended beyond the driving-axle, as indicated, and provided with seats at their outer ends for a wooden cross-beam g^5, securely bolted to the side arms, and in turn readily bolted to the car-floor frame. When the motor-frame is thus connected at its front end with the car floor frame, a small portion of the heavy weight of the motor and casing is fulcrumed on the driving-axle; but the rear end of the motor-frame is mainly supported by the car-floor frame by means of bolts and brackets g^6, projecting from the motor-frame, a wooden cross-beam g^7 being interposed between said brackets and the car-floor frame. Thus the motor is spring-mounted and well guarded against destructive rail-shocks. At both ends of the motor-shaft e^1 there are crank-disks *k k*, properly offset and counter-weighted, and they are connected with wrist-pins on the driving-wheels h^1 by means of pitmen *l l*, which at the crank disks are so jointed as to operate smoothly and obviate injury from such twisting strains as result from tilting movements of the driving axle.



EICKEMEYER GEARLESS ELECTRIC LOCOMOTIVE.

In the organization shown in Figs. 1 and 2, the driving-axle and the motor-shaft normally occupy the same horizontal plane. It will be seen that the attachment of the complete machine to a car involves only the application of four bolts, thus providing for ready disconnection. This feature will enable street railways having limited rolling-stock to hold one or more machines in reserve and to replace a disabled machine in but little more time than is often afforded between trips at home stations, and it is obvious that such machines can be economically applied to an ordinary street car upon the removal of one axle, its wheels and box-jaws. The removal of the driving axle and wheels involves only the disconnection of the pitmen and jacking up the car-body. Access to the armature and one-half of the field-coils involves only the lifting of a detachable section of a car-floor and the removal of the cap of the motor-casing, and the removal of the bottom section of the casing affords access to the other half of the field-coils, all of which can be readily removed and others inserted. The armature-shaft having open-topped box seats, as shown at e^2, Figs. 3 and 4, enables the armature to be readily lifted through the floor of a car, thus involving but little labor for the removal of the armature, as well as the field-coils, and the insertion of others without disturbing the relations between the car-body, motor-frame and driving-axle.

For use with driving-wheels of the ordinary sizes the motor is organized with reference to affording the requisite power when the armature is driven at the comparatively low speed necessitated by the use of such driving-wheels. One form of machine embodies driving wheels of comparatively small diameter, as illustrated in Figs. 5 to 8, inclusive. In this organization the motor B^1, is in all its essential features like that already described; but it is mounted in a different manner. Near each corner of the motor-casing on the side facing the driving-axle *h* there is a pendent hanger *m*, to each of which an inclined axle-box jaw or frame *n* is securely attached. Each frame has a head-block n^1, pivoted between bars n^2, secured in place by rods n^3, which are free to swing on the bolts n^4 by which said rods are fastened to the box-frame. The head-block n^1 is perforated for two spindles n^5, which at their bases occupy seats in the top of the journal-box, and are inclosed by springs n^6, which bear upon collars fixed on said spindles, and are borne upon by said head-blocks, which therefore support one end of the motor and such portion of the weight of the car as is supported by way of the two angle-brackets *o o*, bolted to the car-floor frame and

to the central section of the motor-casing. The rear portion of the motor is supported by means of two angle-hangers o^1 o^1, also bolted to the car-floor frame and the central portion of the motor-casing. The crank-disks k, pitmen l^1 l^1, and the driving wheels A^1 are organized as in the machine first described. In this organization the motor-shaft and driving-axle occupy different horizontal planes and the inclined journal-box jaws secure good working relations in the several lines occupied by the pitmen, and the pulling and thrusting strains, although they operate in lines inclined to the plane of the car floor, cannot cause the car-body to vibrate, and the same is obviously true of the machine first described, wherein the pitmen operate in planes parallel with the car-floor.

It will be seen that no portions of the motor-frames need be made of such expensive non-magnetic metal. In each of the machines shown the central portion of the casing is non-polar or magnetically neutral, the poles in the motors B and B^1 being in each instance located at the upper and lower sides of the armature and casing.

Earthquake Disturbances.

At the last regular meeting of the Franklin Experimental Club, May 19, 1891, Prof. Geo. C. Sonn delivered an intensely interesting and instructive lecture on "Seismology," or the phenomena of earthquake disturbances, and methods of studying the same. Professor Sonn dwelt upon the various theories prevalent upon the subject of earthquakes, tidal waves, etc., and explained the methods adopted from the earliest times to the present day in the study and recording of the various disturbances going on in various parts of the earth's structure. The lecture was illustrated by magic lantern views of the most important earthquakes and their effects, in Japan, Java, Sandwich Islands, Lisbon, Charleston and elsewhere, and also by diagrams prepared by Professor Sonn of the electrical and other methods employed in recording the time and duration of the disturbances, the number and general character of the movements. Some interesting pictures were shown of various buildings and the effects of the shocks upon structures placed in certain positions, and he explained that as nearly all of the impulses moved in one direction, it was customary in earthquake countries to pass strongest laws stating how buildings were to be set, whether windows and doors, etc., would be allowed in walls which ran in certain directions, relative to the seismic movements, the character and material employed. The president exhibited some interesting samples of lava and earthquake souvenirs collected by him at Herculaneum, Pompeii and the Island of Ischia. Professor Sonn sails for Europe shortly, and during his visit abroad will visit the Electrical Exhibition in Frankfort and will prepare an interesting report for the Franklin Experimental Club.

The Munson Belting Company, Chicago.

Accepting the invitation of the genial Col. J. H. Shay, familiarly known in electrical circles as the "Electrician" of the Munson Belting Company, a correspondent of the ELECTRICAL REVIEW visited the large factory of this company recently, and together with Mr. E. A. Groitzinger, made a tour of the entire factory. This company occupy the buildings No. 22 to 36 South Canal street, using to its utmost capacity about 150,000 square feet of space. This does not include the tanneries of the company, which of themselves are very large. The celebrated Munson belting is manufactured from selected hides submitted to an especial tanning process particular to this company alone. The belts manufactured by this company have a world-wide reputation. An especial feature of this visit to the factory was the privilege of seeing the construction of an enormous belt which will be, when in its place on the pulleys, one of the largest belts in this country. This belt is 72 inches in width, is 150 feet long, and will be capable of transmitting power aggregating 2,500 horse-power, being made from selected stock, no piece being longer than four feet two inches. In the construction of this belt the famous Munson cement alone is used, not a thread or rivet being allowed to enter it. In cementing the sections together every inch of it is submitted to a pressure of 150 tons.

The belt is for driving the engines of the Missouri Electric Railroad at St. Louis, Mo. The entire power transmission machinery was furnished by the Hill Clutch Works of Cleveland. The Munson Belting Company have sold in former orders to this railroad belting aggregating over 700 feet.

Chicago, June 4. L. W. C.

Discussion on Prof. Edward L. Nichols' Paper on "A Photographic Study of the Electric Arc."

Prof. Elihu Thomson: I would suggest that a very good thing to try in this connection would be to actually produce, if possible, an arc with a sine curve wave; that is, hold the sine curve wave by a large resistance in the circuit or by self-induction, and then investigate the characters in a similar manner. Of course, the arc would probably deform it some. I can readily understand that the reason for the curve of current taking the form it does is, that the resistance of the arc falling with the increase of current, naturally the moment it begins falls to a point only limited perhaps by the capacity of the apparatus feeding the arc. That is, the vertical line shown in the curve of current representing the arc shows that the moment the arc starts, there is practically no limit to the current which might pass through that arc, if the electromotive force was not extraordinary. That is, under constant potential there would be no limit that would naturally be expected.

There is one matter in connection with the photograph that I might mention here. I do not think you can argue absolutely that the current stops, or that there is an absolute cessation of the arc because the photograph doesn't show it.

It may be that the current flowing is so small as not to give actinic luminosity to the stream, but it is also well known that a photographic plate to develop strongly requires a certain amount of actinic work done on it. That is, taking the ordinary case of a sensitometer used to determine the sensitiveness of the plate. If you put such a sensitometer, consisting of a number of porcelain squares, and expose it to light you will find a development up to a certain number, and after that a quick change. That is, there is a certain quick development after a certain amount of exposure, so that the plate may be resistant up to a certain point, and give way when the light has reached the plate in a certain amount. It may be, as Mr. Mailloux suggests, a sort of coercive force in the plate. I am reminded of the photograph exhibited some few years ago of electric sparks. Some cases of the photography of a spark give a reversed image, that is, giving a dark image on a comparatively light ground. There we have the case of another action of the photographic plate, which is solarization; that is, too much light will cause sensitiveness also. Some of the results seen here may admit of such an interpretation. I notice in the lower part of Fig. 5 what seems to be little dark spaces in between the wider black spaces, and in Fig. 6 that seems rather startlingly shown, and the question there arises whether that is really due to the drop in luminosity, or whether it is due to solarization, but as the curve of current shows a depth there, it probably is due to the drop in luminosity, and not to solarization. Still, that would be a matter to be taken into account in all these cases. The results are certainly very interesting, and the field of work is one which is certainly of great interest to those connected with the application of arcs in practice. Results certainly show that the acuteness or sharpness of the sound -- the noisiness of the arc—is increased by the fact that there is a tendency to absolute break. We can readily imagine that if the curve of the current was a sine curve that the note given out would be a very smooth, musical note; but in the case before us, where the results seem to indicate almost an absolute break in the current, we can understand that it is like a set of lashings of the air, and the noise produced would be sharper and harsher to the ear in consequence. This nuisance of harshness might probably be ameliorated by the suggestions that I made at the start by actually forcing the sine curve current through keeping it as near as possible the sine curve current.

Dr. Otto A. Moses: There is one feature of the arc that I do not recollect to have seen touched upon by any of those who have studied the subject, which I think is here illustrated and perhaps elucidated. The material transmitted, whether with a continuous or an alternating current from one pole to the other, is a volatilized hydro-carbon gas. In that case we have this phenomenon—a column of gas rising or falling according to the direction of the current surrounded by an envelop of oxygen. That is an element not to be neglected. We have, of course, in the oxidization of the hydro-carbon a cause of luminosity independent of the current passing. The interior of such a column of gas would naturally present, through photographic influence, a dark spot.

Professor Nichols: The photographs in this case were secondary to observations with the revolving mirror. I should hardly have ventured to interpret photographs alone, because I am well aware of the difficulty of so doing. But a view of the arc in the revolving mirror makes it evident visually. All that can be said is that the mass is so very small that it doesn't take an appreciable time to cool below the point at which it gives out light. That is the meaning of extinction in the way I used it.

Mr. Carl Hering: I would like to ask, in regard to Fig. 12, whether it was placed east or west or north or south in the magnetic field, and at the same time whether it was a battery current or a pulsating current.

Professor Nichols: Fig. 12 represents a continuous current arc in the same strong magnetic field which was in Figs. 9, 10 and 11, so that that flaming on the side shows that there were two elements moving in one direction and one in the other, and that it was placed east and west, and was under the influence of an artificial field. The lines of force might be considered as parallel to the paper and horizontal. It was a current from an Edison machine—a single lamp with resistance in series sufficient to cause it to regulate properly—probably rather a smooth current.

Fig 5.

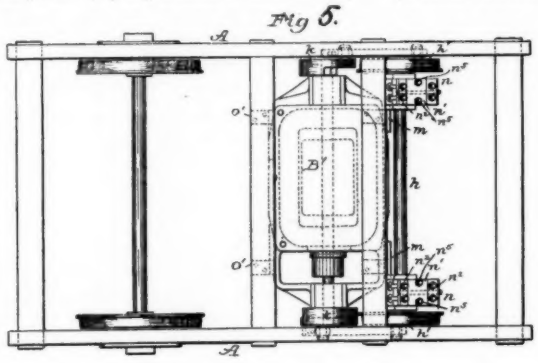


Fig 7.

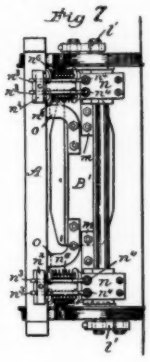


Fig. 6.

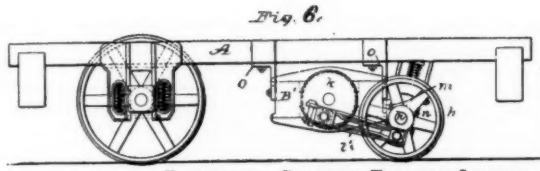
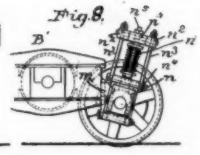


Fig. 8.



EICKEMEYER GEARLESS ELECTRIC LOCOMOTIVE.

Hughes & Gawthorp Sued.

The Thomson-Houston Electric Company filed at Pittsburgh, May 25, a bill in equity against the Hughes & Gawthorp Company and others. The plaintiffs allege that the defendant is indebted to them in the sum of $39,000 and is insolvent, and asks that it be restrained from selling or assigning any of its stock or assets or confessing judgment.

Electric Merchandise Company.

This company has sent out handsomely engraved birthday cards reminding the electrical trade that it was one year old on June 1st. In writing to us about it, Mr. England, secretary of the company, says: "Although it is a fact that our present company is but a year old, yet you are probably aware that the management of the company has been connected with a like company, whose business we purchased, ever since the first practical electric road was put in successful operation in this country, so that although we are as a company young, yet in practical experience we are the oldest and, we believe, the only exclusive electric railway house in the trade."

Portland, Me.—The Palmer Motor Company; capital, $1,000,000.

St. Louis, Mo.—The Nier Engineering Company; capital, $5,000.

Portland, Me.—The Post Engineering Company; capital, $100,000.

Louisville, Ky.—Ream's Electric Clock Company; capital, $100,000.

Dunellen, N. J.—The Dunellen Electric Light Company; capital, $5,000.

South Bend, Wash.—The Willapa Electric Company; capital, $100,000.

Hot Springs, S. D.—Hot Springs Electric Light Company; capital, $50,000.

Bath, N. Y.—Bath Electric Light and Power Company; capital, $25,000.

Chicago, Ill.—The Chicago Optical and Electrical Company; capital, $20,000.

Saco, Me.—The Whitney Electrical Instrument Company; capital, $500,000.

Hastings, Mich.—Hastings Electric Light and Power Company; capital, $15,000.

Tacoma, Wash.—The Consumers' Electrical Supply Company; capital, $5,000.

Long Island City, N. Y.—The Crescent Electric Light Company; capital, $25,000.

Willimantic, Conn.—Windham County Shaver Telephone Company; capital, $5,000.

Rogers Park, Ill.—The Rogers Park Light, Heat and Power Company; capital, $75,000.

Bellwood, Pa.—The Bellwood Electric Light Company, of Blair County; capital, $20,000.

New Orleans, La.—The Gulf Electropoise and Thermo-Electric Battery Company, Limited; capital, $25,000.

Chicago, Ill.—The Lincoln Water, Light and Power Company, to build water works, electric light plant and street railway; capital stock, $250,000. Incorporators, E. D. Blinn, J. F. Mundy and D. C. Turley.

Los Angeles, Cal.—Maguiere Electric Light and Manufacturing Company, for manufacturing, selling and dealing in Maguiere electric arc lamps, etc.; capital stock, $250,000. The board of directors consists of the following: Auguste Maguiere, Joseph A. le Doux, H. Nadeau, V. Ponet and Juan Bernard.

Providence, R. I.—The Rhode Island House has granted a charter to the New England Shaver Telephone Company, with a nominal capital of $1,000,000, to operate a molecular telephone, with headquarters in Providence. Edward S. Aldrich is president; John C. Johnson, secretary and treasurer; Fred. I. Chaffee, manager; Elisha C. Mowry, Joseph C. Johnson, Henry H. Fay, Edward S. Aldrich, John H. Thompson, John B. Branch and William B. Baker, trustees and directors.

Georgetown, D. C.—The Potomac Electric Company is a new organization incorporated in the District of Columbia with a paid-up capital of $25,000, for the purpose of supplying current for power in Georgetown, where there is no legal prohibition against overhead wires. The consent of property owners is requisite for the construction of aerial lines. The company proposes to operate its plant by water-power, having leased an old paper mill plant on the Georgetown canal, and also a portion of the power at the Little Falls of the Potomac, five miles from the city. The officers of the company are: J. C. O'Gorman, of Minneapolis, president; Chief Engineer G. W. Baird, of the Navy, vice president; Neil Dumont, secretary; H. P. Gilbert, treasurer, and M. O'Donnell, general manager. The office of the company is at 1323 Thirty-second street, Washington, D. C.

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Electrical people are looking forward to a very successful meeting at the Montreal convention of the National Electric Light Association. Montreal is a pleasant city to visit in the Summer and a large attendance is expected.

The annual meeting of the Railway Telegraph Superintendents' Association will be held in Cincinnati, June 17th and 18th. These meetings have grown in importance ever since the association was formed some six years ago by that wide-awake telegraph man, Mr. Charles Selden, of the Baltimore & Ohio Railway Company.

Last week press dispatches announced a rumor that Mr. Charles E. Mitchell, commissioner of patents, had tendered his resignation to the President. Mr. Mitchell's only reason was his desire to resume the practice of patent law. The circumstances surrounding the case lead us to believe that the rumor will become a fact. This resignation is a subject for regret, as Commissioner Mitchell's occupancy of the office has been remarkably able and satisfactory. He leaves a clean record behind him.

Additional interesting discussion, relating to the papers read before the recent annual meeting of the American Institute of Electrical Engineers, appears in this issue of the REVIEW. This meeting of the Institute was a particularly successful and instructive one, and pointed the way for much important work in the future.

The cables tell us that the Germans have become disgusted with decapitation as a means of capital punishment, and would like to adopt some more humane method, such as electrocution. If, after reading the press accounts of the Kemmler horror, the German authorities adopt the electric death, we shall miss our guess.

A GOOD WATER POWER.

An electric plant is being installed at Telluride, Colorado. The gold ore at this place is abundant, but of such low grade that the operating expenses until recently were barely covered. The machinery was driven by steam engines, but fuel is now scarce, and the manager recently decided to utilize the water power in the vicinity. A dam was built across the San Miguel River, which falls 500 feet in less than a mile at this place, and from the headgate the water is taken through a 4,000 foot pipe, gradually decreasing in diameter from 20 inches to 12 inches, to the power station, where it is delivered to two six feet Pelton wheels. The loss in transmission between generator and motor over a two and a half mile circuit is said to be barely five per cent.

AN ENORMOUS GAS HOLDER.

One of the London gas companies is bent on rivalling Ferranti in the erection of monster centers for the production of light. Fired apparently by the imposing descriptions of the Ferranti 10,000 horse-power dynamos, the South Metropolitan Gas Company is erecting at East Greenwich, not very far from Deptford, a monster gas-holder of truly startling dimensions. This structure will be 300 feet in diameter and 180 feet high when at its full height; the total weight will be 2,220 tons, of wrought and cast iron and steel. The holder will have a capacity of 12,000,000 cubic feet of gas, requiring 1,200 tons of coal for a full charge. The total cost of the holder, including the concrete tank for its reception, is stated as being upwards of $280,000. Certainly electricity leads the way, but the gas magnates make strong efforts to keep up with the procession.

A COMET DETECTOR.

An ingenious device has been invented by Professor Barnard, of the Lick Observatory, for automatically detecting comets, in which the properties of selenium are taken advantage of. A prism is placed in front of the object glass, but instead of the ocular there is a metallic diaphragm with slits in the position of the hydro-carbon bands in the yellow, green and blue rays from the prism. Light passing through these slits falls on to a plate of selenium which forms one side of a Wheatstone bridge, connected to a battery and an electric bell. The telescope is made by automatic machinery to sweep the arc of the sky in about ten minutes, and then, after shifting northwards about two-thirds of the "field" sweeping back again. The light of Sirius is insufficient to change the resistance of the selenium but with the faintest comet, the balance of the Wheatstone bridge is disturbed and a current is sent to the alarm bell in Professor Barnard's bedroom. Professor Barnard is reported to have said:

"You remember reading of the comet discovered by Professor Zona at Palermo, November 15 of last year? Well, this comet was fairly bright at discovery; but last month, when my machine was just completed, it had become sufficiently faint to be a most severe test. One night, when all the conditions were favorable, I started the finder several degrees from the comet's position and allowed it to sweep back and forth in the heavens. Sure enough, the distant body, barely visible to the eye through the same object glass, was instantly detected, and my experiment proved a complete success."

A METER AWARD.

The Paris meter competition has been decided by the division of the first prize of 10,000 francs between Prof. Elihu Thomson's watt-meter and Dr. H. Aron's "electricitäts zähler," or coulomb counter. The Thomson meter is well known to American electrical engineers as a small, neat and accurate measuring device. The Aron counter was exhibited in this city last year, and an agency for its sale was established here. While it was a fairly efficient instrument, either on account of its cumbersome size or high price, or both, the Aron meter did not achieve the success that was anticipated for it, and the agency has been recently closed. A fully illustrated description of this meter was published in the ELECTRICAL REVIEW for May 3, 1890.

These two meters were tested privately and impartially a short time since, but the results have never been published. The load diagram of the Thomson meter was almost a perfect horizontal line, while that of the Aron counter resembled a very elongated S, the meter running ahead on light load and falling off on full load.

Professor Thomson is to be highly congratulated on securing an even division of the first prize "in the enemy's country." It can be readily understood why it would not have been good policy for the Paris Municipal Council to let the whole prize go to an American inventor. The out-skirts of civilization sometimes catch the dust.

RAPID TRANSIT IN NEW YORK.

The somewhat lukewarm report of the Rapid Transit Commission has been a trifle disappointing to most New Yorkers, and the feeling has been very evident in the casual tone of the comments that have appeared in the daily press, and in the general lapse of all further discussion on a subject which such a short time ago occupied the attention of the public almost to the exclusion of all others. At one time it seemed to us that the commission was being unduly urged by impatient spirits to come to a decision without delay, but we then believed that the commission was engaged in studying the merits of the different systems which had been brought to their attention, with the intention of ultimately adopting one or other of them or a combination of several, and then presenting the city with a full-fledged plan specifying route, road and equipment. Such an undertaking needed time, and to accomplish it we should not have grudged the commission a month or two more than they occupied in arriving at the decision recently given out.

When, however, the report was made public and was found to say nothing more than that an underground road for the West side running under Broadway and the Boulevard, to be operated by some other power than steam, had been decided upon, there was a feeling of emptiness experienced which was disappointing, and indeed, almost ludicrous. It was like seizing a bar of metal believing it to be silver, and finding one's hand bound into the air under the unsatisfactory weight of aluminum. Months ago any half dozen intelligent men in the city would, after a few hour's consideration, have come to the same conclusion as that which the commission arrived at after many weary weeks. New York wants no more ricketty elevated structures and the expense of a viaduct is obviously prohibitive; therefore, nothing remained but a tunnel; and given a tunnel, electricity affords the only clean, safe and certain power for operating trains.

However, after all, half a loaf is better than no bread. The commission has told us officially what we all knew privately months ago, and it is fervently to be hoped that as matters have progressed thus far, the engineers upon whom devolves the duty of selecting the systems of tunnelling, and of operating the trains, will work their hardest and best to satisfy as quickly as possible, the desire and need of New Yorkers for electric underground rapid transit.

Look out for some important advances in the alternating motor field in the next few weeks.

CORRESPONDENCE.

OUR BOSTON LETTER.

Capt. Eugene Griffin, of the Thomson-Houston Electric Company, has returned from his business trip abroad.

Mr. Louis J. Magee, of the Thomson-Houston International Company, will sail from New York for London, Tuesday, June 9, and on arrival in that city will go direct to Berlin, Germany, where he will reside as the foreign representative of the company named.

Messrs. Whitmore & Robinson, consulting electrical engineers, of this city, have established commodious offices and testing rooms at No. 133 Essex street, near Kingston street. This young, yet thoroughly experienced firm, are worthy the patronage and confidence of those desiring any kind of electrical tests made, or having instruments requiring calibrating or standardized.

Electric Motors for Drawbridges.—Boston's new Federal street drawbridge is to be operated by electricity. The Thomson-Houston Motor Company, of Boston, has received the contract for all the electrical work, and expects to have the bridge operating in about one month's time. A 20 horse-power special type railway motor will furnish the power. This will make the fifth drawbridge operated by electricity in this country. The first to be operated by electricity was in Bridgeport, Conn., started about two years ago.

The Wainwright Manufacturing Company of Massachusetts, of this city, reports business in its line as being active and orders for the "Wainwright" feed water heaters steadily on the increase. Among orders received recently by this company are the following: Heater of 125 horse-power for the station of the Economic Electric Company, Brockton, Mass.; heater of 150 horse-power for the Pleasant Valley Coal Company, Salt Lake City, Utah, for use in isolated plant, and heater of 150 horse-power for the Freehold Electric Light Company, Freehold, N. J.

The Evans Friction Cone Company, of this city, report business very satisfactory and steadily increasing demand for the company's friction cones. Managers and superintendents of electric light stations and isolated plants in this country and abroad who have adopted the Evans friction cone, have voluntarily tendered the company very high testimonials as to the reliability, durability and economy of these cones. The company has appointed as its sole representative for France, Mr. E. Bourdillait, of Grenoble, France. This gentleman had already introduced the Evans system among some of the leading electric light enterprises in the country named. Mr. Bourdillait has also furnished Evans cones for use in the large factory of Outhenin, Chalandre Fils & Cie, at Savoyeux, France.

Boston, June 6, 1891. W. I. B.

ADDITIONAL CHICAGO NEWS.

Mr. F. H. Whipple, of New York, spent a few days in Chicago this week.

Mr. C. E. Oldacre, of the Jenney Motor Company, reports an excellent trade.

Mr. W. L. Scott, of the St. Louis Electrical Supply Company, spent a day in Chicago this week.

Mr. Geo. T. Hughes has taken charge of the lighting department of the Great Western Electric Supply Company.

Mr. Wm. Hood has just issued a very neat little four page circular descriptive of his new Jewel incandescent lamp.

The Hazleton Tripod Boiler Company have recently closed some large contracts for their famous "Tripod" boilers.

W. A. Sheldon, general agent of the Schuyler Electric Company, of Middleton, Conn., called at this office this week.

Mr. Geo. C. Du Bois, general inspector of the Interior Conduit and Insulation Company, is spending a few days in the city.

Mr. Clanfield, representing the Western Electric Company, of Chicago, is in the city, looking after the interests of his company.

We have just received a small but handsomely illustrated catalogue of the Jenney Electric Motor Company, of Indianapolis, Ind.

Mr. Harry Osburn, with the Pumpelly Storage Battery Company for some time, is now connected with the Chicago office of the Edison General Electric Company.

Mr. J. H. Harris. Chicago representative of the Heine Boiler Company, has just closed a contract with a large electric company in this city, for three 370 horse-power Heine boilers.

Speaking of lamp cords, the Central Electric Company have secured a "winner" in the new commercial "inconstructible" cord, one of the latest products of the Okonite Company.

The Central Electric Company have just been released from an army of paper hangers, painters, etc., and their handsome offices and salesrooms are, if possible, more attractive than ever.

The receipt of some handsome orders for their famous centennial iron box bell is reported by Mr. Geo. S. Searing, Western agent of the National Electric Manufacturing Company, of New York.

H. A. Kinney, with headquarters at Omaha, will hereafter act as general western agent for the Detroit Motor Company. Mr. Kinney is just completing the installation of a 400 light incandescent plant at Lincoln, Neb., using the automatic compound wound dynamos, manufactured by the Detroit Motor Works.

The G. & C. Company, 703 Phœnix Building, report a great demand for their automatic weather strip. This is a desirable article for all styles of cars, fitting as it does on the bottom of the door, preventing all draughts, rain, etc., when the door is closed, and automatically raising when the door is opened, thereby clearing all carpets and other obstructions. They also handle a complete line of railway supplies.

The Electrical Engineering Company, 320 Dearborn street, whom this journal mentioned several weeks ago as contractors for the interior conduit work for the new pumping works in this city, have about completed their work to the entire satisfaction of the officials. This enterprising company will also do the entire wiring of the new Fair department building; this will be one of the largest isolated plants, arc and incandescent, in the country.

The Wannamaker Car Scale Company are exhibiting in this city an ingenious and exceedingly simple device for accurately weighing loaded cars. The scale is attached to the car occupying a place actually its own, in no way interfering with the present mode of car construction. The services of one man and but two minutes' time being required to weigh anything from one ounce to 100,000 pounds if necessary. A neat catalogue is furnished by this company, The Rookery, Chicago.

The Electrical Engineering Company, of 320 Dearborn street, a comparatively young firm, being formed some three months ago, report having secured some desirable contracts for electric wiring plants, etc. They have secured the contract for wiring the new 17 story office building, "The Manhattan." The firm are agents for the celebrated Perret motor, Standard dynamos and the well-known "Clark wire." Mr. R. H. Pierce is in charge of the electrical department, and Mr. R. E. Richardson of the machinery department.

The Stanley Transformers.—The Stanley Manufacturing Company, of Pittsfield, Mass., have found such a demand for their alternating current transformers and fan motors in the West and South, that they have thought best to establish a depot in Chicago. In the selection of a medium for the disposition of their wares they show an astute knowledge of the means to an end. They have arranged with The Electrical Supply Company, 171 Randolph street, to carry a full line in their capacity as general Western agents. The indefatigable energy of this firm is almost proverbial, and the Stanley people will find they have made no mistake.

The Interior Conduit and Insulation Company have just completed an installation of their famous conduit in the handsome Dunshee apartment building, Chicago. This is the first building in Chicago to have this system complete. There are 410 lights wired and "conduited" complete under the instruction of the Interior Conduit and Insulation Company, the average amount of tubing used being about 20 feet per light. Separate sets of risers are run for each floor. The building is divided into two sections, the mains coming together at the switchboard in the basement. Mr. H. M. Underwood is the efficient manager of the western office of the company. L. W. C.

Chicago, June 6, 1891.

OUR ALBANY LETTER.

The Westchester Electric Railroad Company, of Mt. Vernon, N. Y., has filed articles of association with the Secretary of State. The capital stock is $30,000.

The Edison General Electrical Works, at Schenectady, N. Y., have placed Mr. H. F. Parshall in charge of the street car motor designing and construction department.

The application of the Buffalo Street Railway Company to the New York Board of Railroad Commissioners to use the electric single trolley system instead of horses has just been granted.

The Albany Railway has now placed its handsome force of open motor cars in service and is doing an immense business. The progress of the work of relaying the rails on that portion of the company's tracks in the north of the city is rapid.

The Glens Falls, N. Y., Street Railroad Company is pushing matters rapidly. The power house is nearly completed and the boiler house is well under way. It is expected that the electric cars will soon be running between Glens Falls and Baker's Falls. L. M. W.

Albany, June 6.

Franklin Experimental Club.

At the thirty-third regular meeting of the Franklin Experimental Club, held at the Club's laboratory in Newark, N. J., on the 2d inst., two papers were read.

One was presented by Wm. J. Hammer, and was entitled, "Some Facts and Phenomena About Incandescent Lamps." Some of the facts and phenomena presented were as follows:

Filaments of carbon are preferable to metals, as carbon is far more refractory and is of higher resistance. A vegetable or structural carbon is preferable to a homogenous carbon, as it is first mechanically stronger, just as a hollow column is stronger than a solid one. Then, the walls of vegetable cells are very thin and give a high resistance with a shorter length of carbon than is possible with a homogenous one. This is why nearly all homogenous carbon filaments are either curled, twisted or, if straight, compel the use of exceptionally long globes.

Carbons, after being placed in the globes, are always "tempered" or "flashed," connecting with a small current and finally running up to several times the candle-power at which the lamps will be run normally. This weeds out the poor filaments and drives out the occluded gases in the carbon, clamp and platinum wires in the lamps.

The vacuum in an incandescent lamp varies from one one hundred thousandth of an atmosphere to one-half a millionth of an atmosphere. Generally it is even less than the former. Formerly it was supposed that two high a vacuum could not be attained, but it is now known that there is less strain and disintegration of the carbon and less blackening of the glass at lower vacuums.

Sometimes one sees a lamp which burns more dimly than others upon the same circuit and of the same rated candle-power. This is probably due to a crack in the glass globe and the gradual admission of oxygen, which is causing the carbon to be consumed. An evidence of this will be found in an exceedingly hot globe, also in the spotting of the carbon, which will become bright in spots and gradually waste away until it suddenly breaks at one of the bright spots. An incandescent lamp will last longer in a thin globe than in a thick one, as the heat rays pass through the thin glass and escape, while the thick one holds them and so lessens the life of the lamp. Incandescent lamps are longer lived on continuous than on alternating currents. The rapid reversals of the current shortening the life of the filaments. About 45 per cent. of lamps in central stations are replaced before breaking, owing to blackening of the globes or to the carbon becoming too thin, thus giving less light.

Carbons will eventually be placed inside dishes, cups, etc., electrically connected so as to keep their contents warmed.

A paper was presented by Earl Atkinson, entitled, "Electric Motors." Mr. Atkinson first took up the subject in a general way, describing the more recent achievements and the present state of the arc. He said that while the tendency was toward larger motors in some cases in others it was toward large numbers of smaller motors, as, for instance, in certain lines of manufactures, where each machine was provided with its own separate motor. He then took up the questions more particularly involved in the design and construction of street car motors. These involve the questions of ability to endure without injury the great and sudden changes of load at starting as well as to be run in either direction. Mr. Atkinson stated it as his opinion that when it becomes possible to provide street cars with satisfactory storage batteries connected to slow speed motors attached directly to the car axle, the resulting service will be all that can be desired.

Mr. J. W. Cleary, of the Electric Headlight Company, of Indianapolis, spent a few days in Cincinnati recently and reports that over 30 headlights have been put on by this company. The C., H. & D. road has almost all its engines, both freight and passenger, equipped with this electric headlight, which is gaining in popularity with railroad men.

A Suggestion for the Electric Club and Inventor Edison.

[From Kate Field's *Washington*.]

Electricity seems to be at the bottom of everything, and if so Mr. Edison will soon have the whole world under his thumb. According to the ELECTRICAL REVIEW, a dentist declares that currents of electricity are set up in the mouth between the saliva and many kinds of food, especially such as contain much carbon, like toast.

This same dentist thinks that electric currents are produced when teeth-fillings of different metals occur in the same person's mouth. Good gracious! What horrible possibilities may not such currents suggest! And how many volts—is that what you call them, Mr. Edison?—are necessary to make a bi-metallic mouth strike death to its possessor? Here's a sanitary reason for advocating monometalism.

Furthermore, this curious dentist says he believes that the acute relish we experience when eating certain combinations of food is due to the action of these currents of electricity upon the sense of taste.

Now, my dear Mr. Edison, is this true? If so, does it not become your duty to your fellow man — especially to your fellow woman, who does the marketing for fastidious palates—to tell us what combinations of food are likely to produce the most agreeable currents? After due experiment, would it not be the most delectable of all things for the Electric Club to give a dinner made up of such toothsome foods as science proclaims fit for digestion?

Whoever dreamed that you, Mr. Edison, would add to your glory that of wearing the *cordon bleu*? Yet, if you can rescue suffering humanity from the horrors of inedible edibles, every housekeeper will worship at your shrine, and every six dollars a-week boarder will rise up and call you blessed.

Invent a way by which badly cooked foods can be charged with mouth-watering currents, and, like Alexander, you will have no more worlds to conquer. As you are a wizard, Mr. Edison, this is not asking too much. Is it?

A genius that can invent a kinetograph and make us hear sun spots roar, ought to be equal to—what shall I call it—an Edibattery? KATE FIELD.

New York Electric Club.

At a meeting of the Board of Managers of the Electric Club, on June 4, there were admitted 33 new members—one life, six active and 26 associate—showing that the late rapid rate of growth is being well maintained. About a dozen new applications already await the attention of the Membership Committee. The report of the treasurer showed that the finances of the Club are in a progressively healthy condition. From the statement of the House Committee it appears likely that should the lease by the Club of its present quarters be extended a couple of years, as proposed, the sleeping accommodations will be increased, as there is a brisk demand for rooms all the time.

It has been arranged to have the smoking concert on the third Thursday of this month, June 18, and the Entertainment Committee report that an excellent programme is now secured, with the probability of the addition of other talented performers from the electrical ranks. The concert will be preceded by a business meeting of the Club.

FINANCIAL.

Closing quotations of electric stocks, from F. Z. Maguire & Co., Electrical Securities, 18 Wall street, N. Y., Saturday, June 6, 1891. New York, Boston and Washington Stock Exchanges.

NEW YORK.	
Western Union Telegraph Co.	80⅜
American Telegraph & Cable	80
Central and South American	135
Mexican	200
Commercial Cable Co.	105
Postal Telegraph Cable	80
Edison General Electric Co.	99
" " Deferred	
Consolidated Electric Light	
Edison Electric Illuminating Co.	76
United States Electric Light	80
North American Phonograph	
BOSTON.	
Thomson-Houston Electric Co.	41¾
" " " Preferred	
" " " Series C	
" " " Series D	7
" " International Co.	
" Welding Co.	
" European Welding Co.	
Ft. Wayne Electric Co.	11¾
Westinghouse Electric Mfg. Co.	13¼
Detroit Electrical Works	10¼
TELEPHONE:	
American Bell	
Erie	48
New England	50
Mexican	1.32½
Tropical American	.87½
MISCELLANEOUS:	
Edison Phonograph Doll	.50
WASHINGTON.	
Pennsylvania Telephone	24
Chesapeake and Potomac	62
American Graphophone	53¼
United States Electric Light (Wash'ton)	155
Eckington and Soldiers' Home Electric Railway	49½
Georgetown and Tennallytown:	57

Telephonic News

*** Augusta, Ga., and Charleston, S. C., 157 miles apart, now have telephonic connection.

*** The telephone cable between Norfolk, Berkley and Portsmouth, Va., was cut last week by a dredger.

*** A new telephone line is to be established between Dover and Dexter, Me., by a Piscataquis company.

*** Charles A. Devendorf, for the past six years local manager for the Hudson River Telephone Company, at Schenectady, N.Y., has been appointed manager of the Union Telephone and Telegraph Company with headquarters at Saratoga.

*** The American Bell Telephone Company, May 20, 1891, had 497,405 instruments under rental, against 460,503 a year ago. The monthly statement makes the following comparisons:

May—	1891.	1890.		
Gross output	7,346	6,938	Inc.	408
Returned	3,255	2,135	Inc.	1,120
Net output	4,091	4,803	Dec.	712
Dec. 21 to May 20—				
Gross output	29,713	25,819	Inc.	3,894
Returned	16,094	10,177	Inc.	5,917
Net output	13,619	15,642	Dec.	2,032

*** The Tropical American Telephone Company, of Boston, has just been awarded the gold medal for its "Tropical" telephone sets, both for long distance and for commercial uses, at the Jamaica Exposition. These sets are manufactured for it abroad, and are especially adapted for its export trade in tropical countries. Great care is taken to guard against corrosion of the exposed parts, the contacts are pointed with platinum and the workmanship is first-class in every respect. These export sets are sold outright at prices under those formerly paid the American Bell Telephone Company for its ordinary telephone sets, and many testimonials to their excellence are being received from its customers in South America and West Indies.

*** The annual report of the Mexican Telephone Company says that the Company is now out of debt, excepting an unsettled claim of the Bell Company. The litigation in which the company has been involved for a long time is settled. The company has $12,100 in the treasury and from $1,500 to $2,000 coming now every month. The year's receipts are $99,802, or $21,909 more than the previous year; expenses, $86,711; balance $13,091, of which $12,100 is held in Boston and $991 in Mexico. The increase in expenses for the year was $18,071, of which $14,800 was for legal settlements, payment of bills brought over from former years and expenses connected with the renewal of concessions. The balance sheet shows assets of $2,193,642.

The World's Fair Foreign Chief.

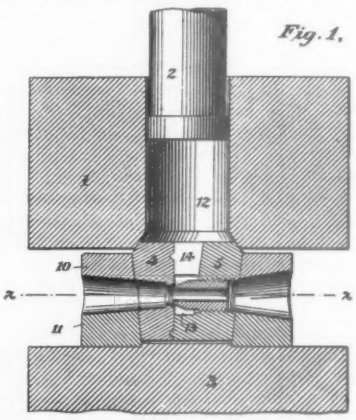
Melville E. Stone, the newly-appointed chief of the department of foreign affairs of the World's Columbian Exposition, is a resident of Chicago, and has a well-established and enviable reputation in journalism throughout the United States. Mr. Stone founded the Chicago *Daily News* in 1876, and in a few years built it up into a very valuable and profitable property, and made it a power both in municipal and national affairs. About three years ago he sold his interest for a comfortable fortune, and since that time, until recently, has been traveling in Europe. Mr. Stone's appointment has been received with much favor by the press and people of Chicago, as his peculiar fitness for the position was at once universally recognized. His wide acquaintance with public men, both in the United States and abroad, added to his exceptional personal qualifications for the position, will enable him to work very efficiently in behalf of the Exposition. This appointment, it is believed, will prove very acceptable to the many foreigners—intending exhibitors and visitors—who will have dealings with the Exposition department of which he is the chief.

Lead Blocks for Covering Insulated Conductors.

The success attending the use of lead as a covering for insulated conductors, especially for underground use, has caused it to be almost universally acknowledged by practical men, in spite of its drawbacks of weight and expense, as a covering which is a reliable protection under almost every adverse condition.

Great attention, therefore, has been given to, and much ingenuity expended on, lead covering "blocks," as the pieces through which the cable passes to receive its covering are called, and we illustrate the last of these for which a patent has recently been

Fig. 1.

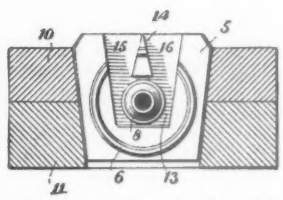


issued. The blocks hitherto used have been designed on what is called the "split block" plan

These blocks are in two pieces laid one on another in a horizontal plane, the upper block being provided with an opening to admit the lead which is forced into it from the lead containing cylinder by a hydraulic ram, and both the lower and upper blocks are hollowed out to receive between them a die to form the outer diameter of the pipe, and a core-bar which decides the inner diameter and which is, of course, hollow to allow the passage of the cable through it. These blocks must be large enough to have sufficient strength to enable them to resist the very heavy strain brought upon them by the action of the ram. The core-bar and die pieces must, therefore, also be proportionally long to enable their ends to be attainable for adjustment, and this is a great source of weakness, for these long pieces require great mechanical precision, to obtain a "seat" which must be absolutely rigid or the "pipe" will be eccentric. When the blocks are cold this only requires care and good workmanship, but to provide for subsequent distortion produced by the pressure of the ram, the heat of melted lead, and the gas blasts which are necessary for keeping the lead plastic, is nearly an impossibility.

As near an approach as possible to a rigid core-bar is obtained by the two halves of the blocks being pressed tightly on each other by means of powerful screws, which have to be tightened up gradually from the first

Fig. 2.



charge as the continuance of the heat increases its effect.

But even then it is but rarely that absolute concentricity of the pipe can be relied on throughout a day's work, and if not carefully watched the lead will, under the enormous pressure required, force itself between the interstices of the blocks and thus destroy the adjustment. Work has then to be suspended or something must break.

Other technical difficulties, too numerous and too tedious to detail here, are also met with in the use of the horizontally split block.

It is claimed for the blocks we now illustrate that all these weaknesses and liabilities to error and distortion are absolutely overcome.

Instead of being split horizontally as in those at present used, whereby the blocks are rendered weakest where the greatest strength is required, the new "blocks," if such they may be called, are split vertically and have in themselves no other function to perform than that of being mere holders for the die and core-bar provided with an opening admitting the lead thereto from the cylinder.

They may, therefore, be made of very light and easily handled proportions. The absolute concentricity of the die and core-bar is obtained by means of an interlocking ring on one piece and a projection on the other, turned on their faces at the same time as the die and core-bar and with the same centers.

This is the only part requiring more than ordinary fair mechanical workmanship. The outside surfaces of these pieces when joined are tapered to a certain angle and are then complete.

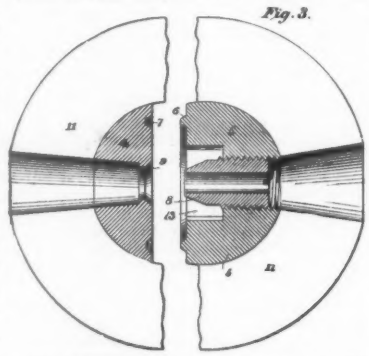
To hold these pieces together they are dropped into a retaining ring bored to the same taper as themselves, and, provided this ring is of sufficient strength and fairly plane on its upper and lower surface, nothing more than strength to resist the bursting of the lead is required of it.

In practice two rings are provided, one-half of the aperture for the ingress and egress of the cable being turned in each. This enables the blocks to be easily taken to pieces or assembled whenever required.

If the lower retaining ring is dropped off, the remaining end of the pipe is easily removed, and the upper retaining ring will, if reversed, fall off and leave the center pieces separate. The shape of the lead duct is such that the cold lead is easily removed therefrom when desired.

The inventor claims that this system is the only one mechanically and scientifically correct, and the difference between it and the old system of blocks may be summed up thus: In the old system the greater the pressure the greater the tendency to produce distortion and displacement of the various

Fig. 3.



parts, whilst with the new system the greater the pressure the more firmly are the parts bound together.

By a slight modification the small triangular piece over the core-bar may be dispensed with, if deemed advisable.

It will also be noticed that the lead becomes pipe at the very moment it changes its direction of flow, whereby friction and consequent waste of power are reduced to a minimum.

The cost of these blocks is about one-third of those on the old system.

The inventor and patentee is Mr. J. Draper Bishop, of the John A. Roebling's Sons' Company, New York.

Electrocution News.

Harris A. Smiler, James J. Slocum and Joseph Wood, all under conviction to suffer death sentence for murder, but who had appealed to the Federal courts, were resentenced by Judge Barrett in the Supreme Court general term, June 2, to be electrocuted at Sing Sing prison during the week beginning July 6 next.

New York Board of Electrical Control.

At a meeting of the Board of Electrical Control, June 2, Mayor Grant offered a resolution authorizing the corporation counsel to give an opinion on the legality of forfeiting the $500,000 bond of the Consolidated Subway and Telegraph Company, because in his opinion the company had wilfully interfered with the rights of the taxpayers in keeping the streets torn up for months after the time agree to by it.

Discussion on Mr. G. W. Walker's Paper on "Electric Meters."

Professor Thomson: As one form of meter which I have designed is mentioned, perhaps I had better confine my remarks principally to that. In the first place, Professor Forbes made a very apt remark in connection with this meter, and that is that it ought not to be called a watt-meter, which is perfectly true. Watt simply indicates a rate. But it is not called a watt-meter. It is called a recording watt-meter; that saves it, that is, it records the rate and integrates the rate for the time. In that sense, of course, it would be proper to call it a regulating watt-meter, recording the rate and multiplying it by the time. The paper before us speaks of this form of the meter, which, by the way, of course, has been designed for a certain purpose, to fit certain conditions. One of those conditions was to give the customer an opportunity to read for himself just as he does with the gas meter record and to understand it. That we found in a good many cases an important matter, and our efforts were spent largely to secure that end, to get, as it were, an instrument that would represent the gas meter recording on a dial the use of current. The instrument, of course, has its limits; that we must fully recognize, but that it does good service inside those limits perhaps is also perfectly true. It will, of course, not readily respond to one volt or to 10 volts, perhaps, but it will respond to conditions of considerable variation in the volt as well as enormous variation in the current. Such meters have been constructed which will range from one to 200 amperes, which, of course, is quite a wide range, and varying only a half per cent. on the lighter load. The accuracy for the heavier loads is almost exact, as exact as such mechanism could be expected to be. The accuracy for the smaller load meters is all that could be desired, taking from 10 to 30 amperes for the small, and the heavy loads are practically accurate, and the sensitiveness is, of course, considerably less than one ampere. It sometimes goes as low as a quarter of an ampere. Now, this matter of the range which a meter can work under is, of course, an important one; and I know no type of meter which has given that much range with the same accuracy, at least so far as my information goes. It is true that the principle of the meter is not new. I claim nothing especially for the principle. I simply claim the working of that principle into a device which is useful in the industrial applications There are features about the meter which did not appear in any former arrangements, and these features I think are features which have made it a success. The same criticism might be made on the meter before us—that the principle of it is not new. The new feature, perhaps, is the recording by a photographing method as distinguished from recording by other methods. I remember distinctly, in, I think it was 1886 or 1887, making a meter which was substantially in principle the same, only the record was made on a sheet of paper by punching little pin holes at intervals. The friction was as little as it is there, and the little point that passed over the paper was clear of the paper until an electro-magnet struck it a blow and made a little indentation, the point jumping up again and being ready to take a different position. That eliminated the element of friction, and I had in that meter an arrangement for doing away with clock work which worked very satisfactorily in the meter constructed. It is nothing more nor less than a pendulum which is self-starting. There was an electro-magnet which pulled upon an armature and a pendulum self-starting. This depending lever of the pendulum was pivoted working a pawl, which gave us the motion of winding for the paper. The pendulum at rest was always stopped in a position ready to start and it broke its own circuit, worked the set of contacts and the magnet kept the pendulum in motion so that our rate was perfectly regular. The little point was mounted on a spring connected with the ammeter, which was merely a little piece of iron on a vertical shaft inside a coil and the coil and the iron shaft so as to get substantial uniformity throughout the length. This little point was over the strip of paper, and the electro-magnet hammer, at every revolution of this ratchet wheel, which constituted practically the whole of the clock work, struck a blow on the paper giving a mark. The paper as it came off would be a series of dots, and then they would change according to the load, and the same process of integrating this curve would be used as in the meter before us. For this purpose we did not waste any energy as here used in working an incandescent lamp for the meter. No doubt the lamp could be diminished in size. But if it should give out from any cause it is not replacable at once, unless some one discovers the difficulty and then the record fails. I do not care to go into any further criticism in relation to this matter; but I think when we look at those things we should be prepared to look at them from all sides.

Professor Thomson: There is just one remark I intended to make when I was up before, and that is in explanation of the statement that the meter has known to turn without load. That is true. The meter was originally developed for alternating currents and was used for alternating currents for a long while, the demand being in that direction; and when it was put upon continuous currents it did not turn and keep turning sometimes in one direction, sometimes in the other direction, when there was no load. The side frames were made of cast iron and they would get under load for continuous currents permanently magnetized with two poles opposite the armature. Of course, the field is exceedingly weak, must have been exceedingly weak, but it was sufficient to cause rotation of the armature. It shows how little force was needed to rotate the armature, the armature being two and one-half inches in diameter and the frames about eight inches apart. That, however, is eliminated by making the frames of brass instead of cast iron.

Professor Anthony: I would like to inquire of Professor Thomson if the meter would not run in the earth's magnetic field?

Professor Thomson: We have got certain indications of that. We have thought sometimes that it had a tendency to turn, but the co-efficient of friction is, fortunately, generally large enough to prevent that.

Professor Anthony: I had a little experience with one of the meters, and I never tested it for that, but I know that the two main coils were connected in the armature circuit so that there was a little tendency to run any way. Of course, the idea was to overcome the friction and I set it up in such a position that the earth's horizontal lines of force were in the same direction as the lines of force developed by the main coils, and the meter continued to run when there was no current in the main wires, except the small current that went through the armature. I had always in mind to take the meter and turn it around the other way, so that the earth's magnetic field would go in the opposite direction and see what effect it had.

Professor Thomson: If the meter were set east and west it would obviate the difficulty. By the way, it is true that with the very largest capacity of meters the shunt is beyond the main coils, so that the shunt current through the armature goes through the main coil, and the purpose of that is, of course, to make the co-efficient of friction disappear as far as possible, in the instances in which the lighter mains work at very high loads, and also be sensitive to the lowest load.

Mr. Birdsall: Mr. Walker says that he thinks the customer would not care what the record was as long as it was explained to him, or that he would not know what watts meant, etc. That is all very true. But I have had experience with the dear public, so to speak, in connection with a chemical meter, and the great cry always was when there was a dispute about the bill that the thing had no dial on—no figures—that those little bottles did not show them anything, and when you branched out into the number of milligrammes of zinc deposited per ampere, why you generally talked alone. I do not think it matters what the dial registers, so long as you have a dial. (Laughter.) The customer does not care whether it is lamp hours or watts or horse-power. The mere fact that he has a number—that he has 75 of something, is all that is necessary. He knows he pays so many dollars for so many things, and he is willing to pay the money as long he is pretty positive that he gets them. The action of the meter I do not think is such an awful thing to strive at, because if the dial says 75 and the man burns 60 he will pay for 75. (Laughter).

Mr. E. Wilbur Rice: Before this discussion is closed, I think it is proper to remark that even in cases where the Thomson meter has been found to register where the whole current passes through the meter, the amount of such register is exceedingly small, and it would take a long time before it would run up a large bill against the customer. In regard to Mr. Walker's remarks in reference to the dial, the last speaker has stated what I had in mind so fully that I do not know that I could add anything to it. I have one of the Thomson meters in my house and it is quite a convenience to be able to read the dial and find out how many watt hours I have burned during the past week, and caution people in the house not to leave the lamps burning in the garret and cellar. But in spite of that I come home and find the house ablaze from top to bottom. In reference to the fact that a customer would not know what a watt hour is, I think it is also true that the average customer has no idea what a cubic foot of gas means. I do not think that the average customer knows that a gas burner consumes, say, five or six cubic feet of gas per hour. He knows he pays one and a half or two dollars per thousand cubic feet. That is exactly the case with the Thomson watt-meter. The register is in watt hours. The price is so much a watt. It happens to come out very nicely, one-tenth of what the price would be. That is, 1,000 watt hours is equivalent to 100 cubic feet of gas.

PERSONAL.

Lieut. J. B. Murdock, U. S. N., is traveling through Europe under orders from the Navy Department, making an examination of electrical industries with special application to marine uses.

At Netherwood, N. Y., June 10th, Mr. Arthur F. Stanley and Miss Mildred Beckwith were married. Mr. Stanley is prominently known in electrical circles as a genial and capable fellow and the senior partner of Stanley & Hall, of this city.

Commander Royal B. Bradford, who became so well known to electrical men while in charge of the Electric Lighting Bureau of the Navy Department, has been assigned to the command of U. S. Steamship "Bennington," which is now at the Brooklyn Navy Yard.

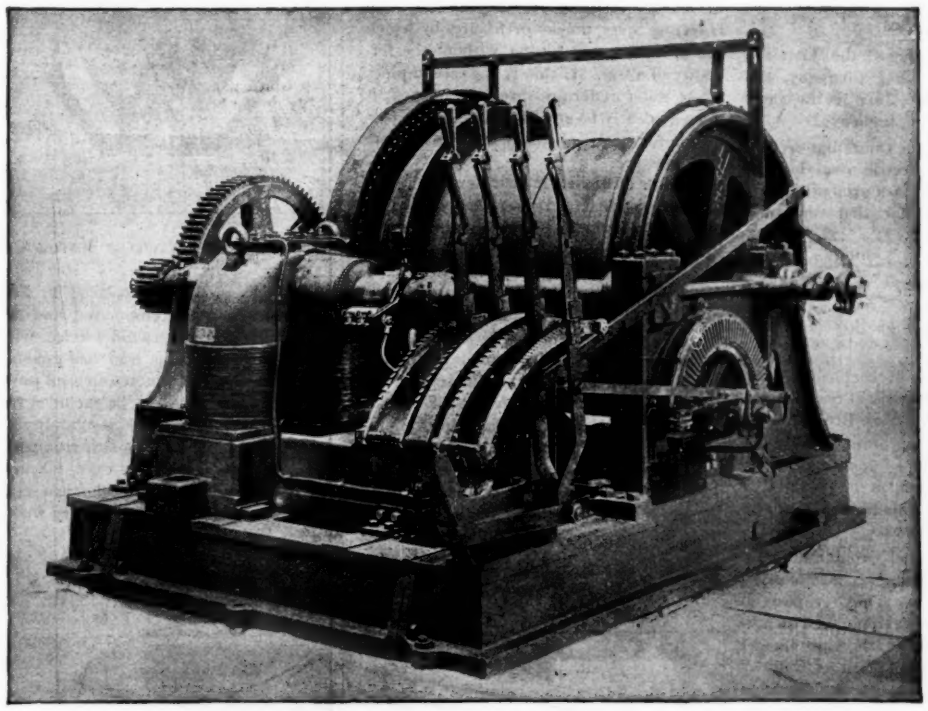
The Trustees of Delaware College, at Newark, N. J., have elected Prof. F. A. Wethe to fill the newly created chair of mechanical and electrical engineering. He is from the Iowa Agricultural College. A committee was appointed to secure specifications for the new $25,000 building, in which electrical and mechanical engineering, mechanics, arts and other branches will be taught. The recent legislature made the appropriation for the building.

The Thomson-Van Depoele Electric Hoist.

The ease with which the locomotive may be helped out, where an incline occurs in the haulage way, by means of stationary electric hoists operated on the same circuit with the locomotive, and by their use making possible the employment of much smaller locomotives than would be possible otherwise, is one of the many advantages of the electric system of haulage for underground work. For instance, for certain haulage work in a coal mine, a 40 horse-power locomotive is necessary. As the entry is driven forward a fault is met in the measure, and the grade for a comparatively short distance is so increased that the locomotive already in will be unable to handle the work. An auxiliary stationary hoist set up at the top of this hill will remedy the difficulty. For this work special apparatus is necessary and the Thomson-Van Depoele Electric Mining Company, Boston, has gotten out electric hoists particularly for underground haulage plants.

Our illustration on this page shows one of these as recently made for a Western coal mine. The plant originally consisted of one hoist, but its work and the results obtained by its use proved so eminently satisfactory that two other hoists were immediately ordered. The outside dimensions of the hoist are nine feet by seven feet four inches, and the total height is nearly six feet. The motive power is furnished by a Thomson-Houston motor of 35 horse-power and wound for a potential of 440 volts. It is series wound and runs normally under load at a speed of 1,100 revolutions per minute. A speed reduction from the motor armature to the drum of 25½ is accomplished by one intermediate shaft with proper gears and pinions. This gives a rope speed of a little over 500 feet per minute or 0.492 feet per revolution of the motor.

The drum, which is mounted on a sleeve and is thrown into action with the large gear by a friction clutch, is four feet in diameter with a 36 inch face. Its rotation, when running independently, is governed by two hand brakes which extend around nearly the entire circumference of the drum. The outfit is equipped with five controlling levers, four of which are shown in the illustration. One operates the rheostat contact, one the drum clutch, two are brake levers, which are entirely independent of each other, and the last throws the reversing switch, giving the drum, when thrown into action with the motor, positive motion in either direction of rotation. The controlling levers are all latched and all within easy reach of the operator. The gears and pinions are noiseless and carefully covered to prevent accidents, and the motor has self-oiling bearings. The Thomson-Van Depoele Electric Mining Company is getting out hoists of this general description in varying sizes and for different capacities.



THOMSON-VAN DEPOELE ELECTRIC MINING COMPANY'S HOIST.

Paris Meter Competition.

Prof. Elihu Thomson is in receipt of a cable dispatch from Mr. Ernst Thurnauer, the Paris representative of the Thomson-Houston International Electric Company, stating that the first prize of 10,000 francs in the competitive electric meter test, instituted and carried on under the auspices of the Paris Municipal Council, has been divided between the Thomson and the Aron meters.

Mr. Pfannkuche Sues the Brush Company.

Gustav Pfannkuche has sued the Brush Electric Company for $150,000. Pfannkuche is a native of Vienna, Austria, and a well known electrician.

He claims he contracted with the Brush Company, July 13, 1887, to enter their employ, his special business being to develop a long distance system of incandescent lighting. Pfannkuche was to assign to the company all title to inventions theretofore made by him and agreed to assign any which he might make while in their employ, and claims to have transferred 10 patents to the company the first year and 12 the second. In February, 1891, the company notified him that his services would not be desired after the end of the month.

The experiment of telegraphing money orders appears to have been successful in England, for the British postmaster-general has intimated that money may now be transmitted by telegraph order between all head and branch offices in the United Kingdom at which telegraph business is done. The amount of any single order must not exceed £10.

TELEGRAPHIC

.... The Philadelphia, Reading and Pottsville Telegraph Company will adopt the system of telegraphing money to all points on the Western Union lines.

.... The District Commissioners are advertising for proposals for the yearly supply of telegraph and telephone materials for the Washington Police and Fire Alarm Service.

.... The Syracuse, N. Y., District Messenger Company has severed its connection with the Postal Telegraph Company and entered into a contract with the Western Union to collect and deliver telegrams for that company.

.... The number of sentinels in the garrison at Halifax, Nova Scotia, has been reduced nearly one-half, and, instead, electric bells have been substituted, which are attached to the sentry boxes and connected with the guardrooms, so that the sentries can send in a prompt alarm to the guard.

LITERARY.

"Protection or Free Trade," by Henry George, has been received. It gives a fair and full presentation of the vexatious tariff question, and no one can be harmed by reading it.

"Pantobiblion," edited by A. Kersha, comes to us from St. Petersburg, Russia. The work aims to be an international bibliographical review of the world's scientific literature, but the attempt falls far short of success; this will be understood when it is stated that "Pantobiblion" is a monthly publication of 287 pages 6½x9 inches in size. Such an ambitious undertaking is worth much more space.

The June *Century* has an interesting frontispiece portrait of George Mifflin Dallas, formerly vice-president of the United States. This portrait accompanies the second and last instalment of the papers extracted from Mr. Dallas' journal, written while he was American Minister to the Court of the Czar, Nicholas I. In this instalment he describes not only the great luxury and splendor of the Court, but tells about hearing Thalberg, the great pianist, and Sontag, the famous singer. A portrait of the Empress is printed with the article.

The June number of *The North American Review* is the 415th issue of that standard periodical, and brings to a close the 152d volume, of which a careful index is included in this number. A glance at the index discloses among the notable contributors during the first half of the year the names of Emilio Castelar, Joseph Chamberlain, Henry Clews, Sir Charles Dilke, Sidney Dillon, Richard T. Ely, Cardinal Gibbons, Dr. William A. Hammond, M. W. Hazeltine, Lecky, the historian, the Hon. Henry Cabot Lodge, the Marquis of Lorne, Justin McCarty, the Count of Paris, ex-Minister Phelps, Bishop Potter, ex-Speaker Reed, Secretary Rusk, H. A. Taine, Sir Charles Tupper, Erastus Wiman and Walt. Whitman. The longest article in the number is by Andrew Carnegie. He entitles it "The A B C of Money," and in the course of the article he considers *in extenso* the silver question and the evils that would follow free silver coinage. Mr. Carnegie's article is written in the clearest style, and cannot fail to be helpful to all who wish to arrive at a clearer understanding of the subject he discusses.

* * A number of electric roads in different parts of the country will begin business July 4.

* * The Second Avenue Electric Railroad, Brooklyn, N. Y., went into regular operation May 28, at 4:30 A. M.

* * The Oakland and Berkeley, Cal., Rapid Transit Company will soon commence the construction of another electric railroad.

* * Hartford's storage battery car will probably be used in towing freight cars between Hartford and the Glastonbury, Conn., factories.

* * An electric freight locomotive is being built at the Thomson-Houston factory, at Lynn, which will weigh ten tons and be of 60 horse-power.

* * John Kelly, an employé of the Ansonia, Conn., Electric Railway, last week received a shock of 500 volts. He burned his hands and ear a little.

* * The annual meeting of the Thomson European Electric Welding Company will be held at Portland, Me., June 10, the books to be closed June 1 to 10, inclusive.

* * The Ohio Supreme Court has decided that a single trolley electric road has the right to use the earth as a ground, even if it knocks out telephone lines that were using it first.

* * The Attleboro, North Attleboro and Wrentham, Mass., Electric Street Railway Company last week entertained a party of 112 persons, who made an inspection trip over the lines.

* * The application of Stephen C. Halstead, the owner of property at Second avenue and Forty-second street, Brooklyn, N. Y., for an injunction restraining the Brooklyn City Railroad from completing the Second avenue electric road, on the ground that it interfered with his rights in the street, was denied by Judge Bartlett.

* * The Old Town and Orono, Me., electric street railroad companies consolidated by a vote of the directors. They propose to build an electric railway from Old Town to Orono, and possibly to Veazie, a distance of eight miles. The Bangor Street Railway Company will extend its line to Veazie in the latter case, making a continuous line from Bangor to Old Town, 12 miles long.

* * Articles of incorporation of the Oakland, San Leandro & Haywards, Cal., Electric Railway Company have been filed. The capital stock is $500,000. The directors and subscribers are Henry W. Meek, W. E. Meek, William J. Landers, Charles E. Palmer, E. B. Stone, Thomas Prather, Edson Adams and A. L. Stone. The directors are considering the feasibility of a proposition to commence work on the proposed road to Haywards very shortly and run it on the San Leandro road to Park street, thence to Alameda, which place will be made the terminus. The Oakland City Council has refused the company a franchise.

* * The Twin City Rapid Transit Company filed articles of incorporation at Elizabeth, N. J., June 4. The incorporators and stockholders are: George Bliss, of Morton, Bliss & Co.; George S. Coe, president of the American Exchange National Bank, New York; Henry W. Cannon and J. Kennedy Tod, New York; Charles Fairchild, Massachusetts; Thomas Lowrey, Minneapolis, and ex-Congressman John Kean, Jr., president of the National State Bank, Elizabeth. The syndicate will deal in street railway bonds and stocks, and construct and operate street railways in St. Paul and Minneapolis. Their capital is placed at $20,000,000, and they will begin with $1,000,000. The principal office will be in the National State Bank building in Elizabeth.

Lead Covering for Electrical Conductors.

BY J. DRAPER BISHOP.

Experience not infrequently demonstrates that first principles are superior to later ones, supposed to be improvements, but which, having perhaps passed every other test with success, have failed before the destroyer Time.

In no instance have we a more forcible example of this than that presented in underground cables. Lead pipe as a protector to telegraph conductors was one of the first materials proposed and used, but was abandoned on account of difficulties in making long lengths, the faultiness of the joints, its weight, the unhandiness and inadjustability of the machinery, and other mechanical drawbacks.

But by improved machinery these objections have been overcome, and the obsolete method of drawing short lengths of cable into shorter subdivisions of pipe has been abandoned for the superior process of making the pipe around the cable in one continuous length.

That cable so covered is perfectly protected (if made by the hot-lead process) is evident from the fact that by all plumbers and consumers of pipe the coils are accepted from the makers as being perfectly air-tight and free from holes, cracks or fissures by which gas or water may escape, without the formality of a test. If this is the case in pipes where water under pressure is conveyed, it must evidently be an absolutely secure protection for electrical conductors where there is no pressure.

As to its durability in ordinary soil, it will suffice to say that lead pipes conveying water to public fountains buried underground some eighteen hundred and odd years ago, are at the present day in perfect order and conveying water in the recently uncovered ruins at Pompeii and Herculaneum.

In this connection it may be interesting to remark that these pipes were made in lengths, to all appearance drawn, as the scoring on the surface is in many places still visible. The joints are also the swelled wiped joints, without the least apparent difference from those of the present day, and in some cases the "wiping" was done with the iron. Whether "wiped" with a cloth "pad" or by the iron was evident from the appearance of the joint. On one of the joints of a pipe leading to the marble bath or aquarium in the center of a newly discovered villa at Pompeii, the writer noticed two initials and a number, warranting the presumption that in those days plumbers were better kept in check than at present. A very slight scrape with the boot showed the lead beneath the surface as bright and fresh as new.

Under ordinary conditions, therefore, we may look upon lead as practically everlasting.

Many young electricians, and for the matter of that, many old ones, too, of the present day think that such gums as india rubber, gutta-percha and their compounds have in themselves some inherent quality which assists the "insulating power" independently of their moisture excluding power, but it is doubtful if this is the case. Whether they have or no, it is safe to say that they may be considered as the best insulators because they act the part of a good mechanical separator between the conductor and the water, if under water, and through moisture to the earth, if underground.

In either case they have to be protected from insects and the rotting influence of foreign vegetable and chemical matter. For submarine purposes the lengths of conductor are such as to render a lead covering impracticable, and it is replaced by hemp saturated with pitch compound and wire armor, but for underground service, which is so rapidly increasing, lead has gradually worked its way into almost universal preference. Provided moisture be excluded from the ends, the lead may be absolutely relied upon to maintain the insulation under the worst possible conditions, even when the insulator is nothing but a mechanical separator, such as crumpled paper or dry wooden or glass balls.

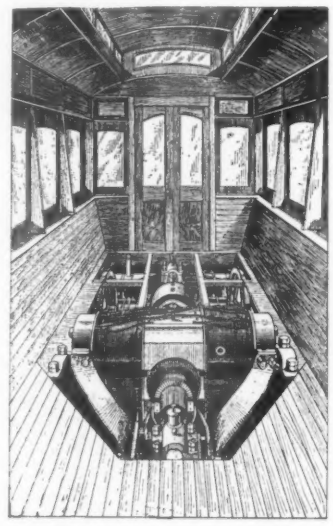


FIG. 2.—INTERIOR VIEW OF MOTOR CAR.

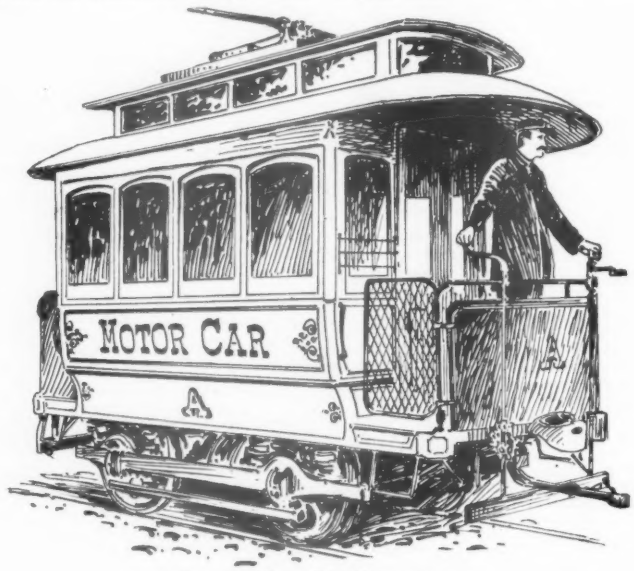


FIG. 1.—WEST END MOTOR CAR.

It is safe to say that until mother earth resigns her prerogative of destroying all vegetable matter, or until some cheaper and more easily worked and permanent metal be discovered, that lead will hold its place as an irreproachable, if not everlasting, cable protector.

The general electric wire trade, which has been dull for two or three months past, is now improving. A number of leading manufacturers report business gradually but surely increasing, and inside of 60 days a very active market may, we think, be expected.

A New West End Motor Car.

The West End Street Railway Company, of Boston, in order to test the relative efficiency and economy of operating their cars by two motors mounted on the truck in the ordinary manner, or of one large motor mounted in an independent car, have had constructed in their own shops an electrical locomotive or motor car which will be put in operation upon their lines. The motor car is 15 feet over all, the body being 10 feet, and is lighted by four windows on each side, with two small end windows and swinging doors, the door space being three feet in width. The platforms are provided with only an ordinary iron step to enable the motor man to gain the platform. The platforms are railed in with gates, but the car is not designed to carry any passengers. The weight is about 12 tons. The motor is of the Siemens type, and is calculated to develop normally 40 horse-power, the armature making from 1,100 to 1,200 revolutions per minute. At a speed of 20 miles per hour the armature makes 1,500. The commutator has 72 segments.

The interior view of the car, Fig. 2, shows the motor mounted well above the ordinary car floor, free from dust and dirt, and in position to give ready access to all its parts. The motor is mounted on the Bemis truck, with a six-foot wheel base.

The fields are of the best wrought iron and are three feet three inches long, ten inches in diameter at the spools and 12 inches through at the pole. The field bobbins are wound with 12 layers of No. 9 wire, B. & S. gauge, three loops being taken off at the sixth, eighth and tenth layer. All field connections are in multiple. The armature is 14 inches in diameter and is wound with the ordinary double Froehlich No. 8 wire, B. & S. gauge. The armature and intermediate shafts are each three inches in diameter, and the intermediate is mounted beneath the armature shaft and parallel to it. All the bearings are from eight to nine inches long. The power is transmitted to the intermediate shaft by a spur pinion on the armature shaft, which in turn transmits the power to both car axles by bevel pinion and gear. The armature pinion is 11 inches in diameter, and the reduction from armature to intermediate shaft is one to two, and from the intermediate shaft to car axle one to four.

All the gears and intermediate shafts are entirely enclosed in oil-tight casings made of 1¼-inch cast iron, none of the working parts being exposed, except the commutator, armature and a portion of the armature shaft. The gear casings are made of unusual thickness for the purpose of deadening the sound of the gear and to increase the weight for additional traction, and to give the casing sufficient strength to support itself from one axle to another without additional framing, as shown. A portion of the casings enclosing the intermediate shaft are cylindrical in form, and are sleeved upon each other, allowing a slight oscillating motion between the two ends.

The following account is given of a run during which the readings were taken by Professor Hooper, of Tufts College, and Mr. Pearson, the electrician of the West End Company. The run was made from the Bartlett street stables of the company to the Tremont House, a distance of 2½ miles, and return, the return being made without a load. The outward trip was made with three cars in tow, each weighing six tons and loaded with 13 tons of meal, a total load of 43 tons. The run was made at a busy hour on the usual time of the ordinary cars. The only incident of the outward trip was the blowing out of a fuse while attempting to start on a grade crossing at Boylston street. The capacity of the fuse was then increased, and the Tremont House reached without further trouble. The average flow of current for the trip with the load was 60⅞ amperes, or 36 horse-power. The maximum current used during the trial, including the grade, was 240 amperes. With a load of 30 tons the average current consumed, including down grades where train was in motion but had no current, was found to be about 85 amperes, while the horse-power used was 47.6. The maximum current was 350 amperes. This was consumed in starting after the car had stopped on a grade at a crossing. On the return trip, 2½ miles, when the car was running light, the average current consumed by motor, including down grades when no current was used, was 30 amperes, or 18 horse-power. A further exhaustive test will be made before it will be decided to operate all the cars in this manner, but another motor is already under construction which will embody such improvements as have been suggested by the operation of the one herewith illustrated. We are indebted to the Boston *Globe* for the accompanying illustrations.

Clemons Chandelier Cut-Out and Key Socket.

M. E. Clemons, Attleboro, Mass., manufacturer of electrical supplies, carries in stock the cut-out and socket shown in the

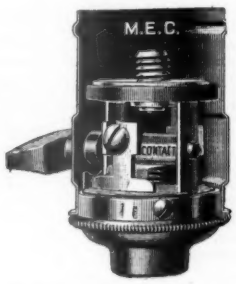


FIG. 1.—SIMPLEX SOCKET.

illustrations on this page. The cut-out in the socket is reinforced by a spiral steel spring not in circuit, so that it cannot be annealed and thus lose its temper. The lugs for holding the wires are also of novel construction. This socket, known as the

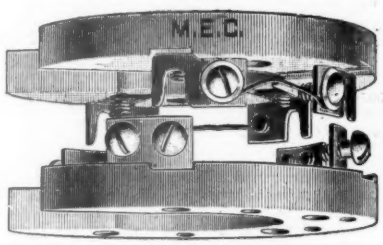


FIG. 2.—CLEMONS CHANDELIER CUT-OUT.

Simplex, is made to fit any lamp, and is manufactured in either fibre or porcelain.

The chandelier cut-out is separable, so that it can be fused on the floor without disturbing the line or lamp wires.

The "Jewel" Lamp.

The new "Jewel" incandescent lamp which Mr. Wm. Hood is introducing is having a ready sale. The lamp is made by the Chicago Incandescent Light Company, who have now in full operation a "model" incandescent lamp factory. This lamp, though probably the newest in the market, has received some very severe tests, and has stood up to all the claims made for it. Electrically it has proven itself to be as near, if not nearer perfect than any lamp on the market; mechanically it is without a rival. It is claimed that a certain process of treatment to which the filament is subjected makes it practically indestructible.

Aluminium Shades.

The Electrical Supply Company, 171 Randolph street, Chicago, have sent us samples of a new aluminium shade for incandescent lamps which they have just put upon the market. They are handsomely finished in several styles, one of which is shown in the accompanying illustration. They are five and three-quarter inches in diameter at the

ELECTRICAL SUPPLY COMPANY'S ALUMINIUM LAMP SHADE.

mouth, very light, and possess considerable reflecting power. Their production is another evidence of the progressive management which characterizes the Electrical Supply Company at all times.

Additional bonds are to be issued by the Gainesville, Ga., Electric Company to add an incandescent light system to the present plant.

The Hay-Horn Electric Bell.

The accompanying illustration represents the new bell manufactured by Hay-Horn Manufacturing Company, of Chicago. This bell is not only attracting attention in this country, but is being used extensively in foreign countries wherever samples have been tested. The object of the manufacturers in making this style of bell is not only to reduce the cost nearly one-half, but it has been found to possess advantages over other bells, viz., loudness of tone, and requires less battery current. Much time is generally required in adjusting the hammer of a bell,

HAY-HORN ELECTRIC BELL.

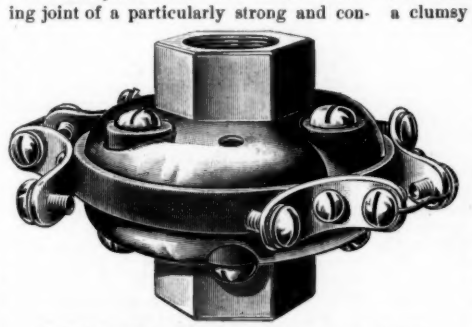
so as to produce the best results, but the manufacturers have overcome this trouble by introducing an adjustable hammer, enabling one to set it right very quickly.

The bell is well made and finished, having platinum contacts, and is tested on a circuit of 200 feet, using only one cell of battery.

Eastern consumers can have advantage of low express rates and prompt shipments by ordering of Jas. H. Mason, Eastern agent, 118 Park avenue, Brooklyn.

Electrix Combination Cut-out and Combination Joint.

We illustrate herewith a new device, manufactured by the Star Electrix Company, of Philadelphia. It consists of an insulating joint of a particularly strong and convenient type, to which is added a neatly arranged, double-pole cut-out device. By the use of this combination joint, a separate cut-out at the fixture is dispensed with, and the whole arrangement is covered by the canopy of the fixture. Without the brass clips and the fuse, it can be used as the ordinary insulating joint.



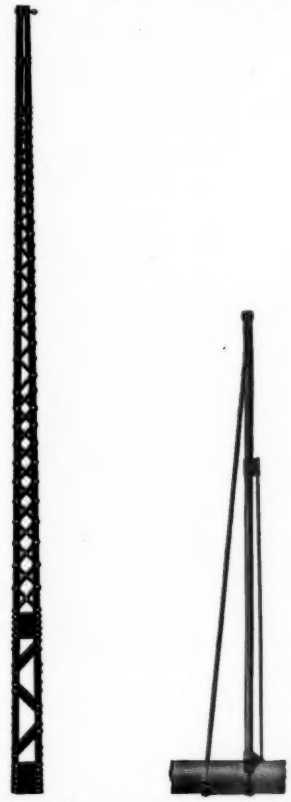
ELECTRIX COMBINATION CUT-OUT AND JOINT.

The Universal Arc Lamp.

The Universal Arc Lamp Company, of Broad street, this city, are having excellent success with their lamps upon incandescent circuits. Upon recent electric railway service tests, the lamps gave full satisfaction, consuming minimum current, and giving a bright noiseless light, without flickering or hissing. On account of the great variation in the voltage in such lines, the test is considered very noteworthy and a good recommendation for the reliability of the lamps under varying circumstances. The lamps will burn in almost any position, as indicated in the company's announcements. They report large sales and a very bright outlook for the future. Having more than doubled their former factory facilities, the officers of the company now promise immediate deliveries, and will be pleased to correspond with all owners of electric lighting plants in relation to using arc lights on incandescent circuits.

Giles Steel Railway Poles and Brackets.

The Giles steel railway pole, Fig. 1, is made up of four angle sections, forming the four corners of a square. To resist the pull of the span wire is a simple matter of making these angles of sufficient size and weight to furnish the required cross section. The pole being square, offers as much resistance to pull in one direction as in another. At the grade line, where the chief trouble is, the angles are separated by two large plates. These poles can be set to pull against a



GILES STEEL RAILWAY POLE AND ARM.

stone or other solid packing without danger of crushing. The design of the pole is neat and light, tapering from the ground up, and as it is latticed and open, it does not present a clumsy appearance. This pole is especially designed for the heavy strains met with in double track and curve work.

The Giles steel railway bracket, Fig. 2, is of the best lap or butt-welded steel tube, held in place against the lower plate of the bracket by a wrought iron clip riveted to the same. This plate is clasped to the pole, no screws or spikes being necessary, and is of such size and shape as will allow of ready attachment to poles of different diameters. The load is directly supported by two truss rods of steel, which pass on either side of the pole and are attached to a heavy bar or plate. They are provided with a bolt and nut, by means of which the height of the arm is adjusted. A smaller rod is run on the under side of the arm which prevents raising it by the trolley passing under. This is a rigid bracket, free from swaying motion, lifting or springing. They are made of first-class materials, in a first-class manner, and are fully guaranteed. These devices are handled in the West exclusively by the Illinois Electric Material Company, 158 Fifth avenue, Chicago.

American Society of Mechanical Engineers.

During the June meetings of this society and the Master Car Builders' Association, to be held in Providence, R. I., Armington & Sims will have running different types of their high-speed engines. Invitations to visit this immense engine manufacturing plant have been extended to both societies.

Mexia, Tex., is discussing electric lights.

ELECTRIC LIGHT NEWS

—— Luling, Texas, wants electric lights.

—— Loveland, Colo., is talking electric lights.

—— The Pettingill-Andrews Company, Boston, has declared a quarterly dividend of two per cent., payable July 1, to stockholders of record June 20, books being closed between these dates.

—— Sealed proposals will be received by the Common Council of the city of Fort Wayne, Indiana, for lighting the city with either gas, electricity, gasoline, or either combined, for three years, with the privilege of five, from July 1st, 1891.

—— In the case of the United States Electric Light Company *et al. vs.* the Consolidated Subway Company, of New York, Judge Ingraham vacated the injunction, which means that, unless the electric light companies using the subways pay about $50,000 yearly rental, they will be cut out.

—— The electric light plant at Bismarck, N. D., has been shut down, and the engines and dynamos shipped East to be sold. A few weeks ago the city council, on being apprised of the fact that there was a big discrepancy in the treasury usually filled with the revenue from the saloon men, resolved then and there to knock off some of the expenses. Electric lights were ordered out—hence these tears.

—— The Hunt Engineering Company, 238 Washington street, Brooklyn, have acquired the agency for the Buckeye Electric Company, manufacturers of incandescent lamps, through the employing of Mr. E. W. Hickcox, as their general salesman. Mr. Hickcox was formerly the Buckeye's Eastern agent with offices at 120 Liberty street, New York. Both offices will now be used in the Hunt Engineering Company's interest.

—— The electric light plant which is about to be placed in the Philadelphia City Hall will comprise 30 miles of copper wire, and over ten miles of interior conduit tubing; 243 rooms are now permanently wired, of which 57 have new combination gas fixtures and electroliers, and 44 have lights through temporary attachments. The plant contemplates 10,400 lights, not including those for the tower, and 1,244 are now connected.

The Swinging Ball Lightning Arrester.

The swinging ball lightning arrester, the latest device of this kind, while offering a quick and sure path to the earth for all static discharges, renders it impossible, it is claimed, for the dynamo current to follow. It has no fuses, and requires scarcely any attention, but it is better to inspect it after a severe thunder storm, as while the line would be protected from injury, the instrument itself might have suffered. This, however, is not thought probable.

It is protected from all moisture, and there are no electro-magnets or intricate parts to adjust. Each arrester is provided with a terminal wire to be joined to the line and a binding post for the ground connection. Where converters are in use it is recommended that one be placed between each converter, and on incandescent circuits on the outside of the building or pole where the circuit enters.

Formerly it has been customary to take care of the lightning at the stations. By this system the lightning is taken care of on the line. The theory is, that lightning should never reach the station, but in case the lightning should get between the station and the last arrester, it is deemed advisable to place an arrester between the dynamo and the point where the line enters the station.

All these arresters undergo a strict test before leaving the factory, and are ready for placing on the circuit when shipped.

This device has been put upon the market by Truex & Vail, Electrical Exchange Building, New York.

The Future of the Aluminium Problem from the Chemical Standpoint.

READ AT THE GENERAL MEETING AMERICAN INSTITUTE ELECTRICAL ENGINEERS, THURSDAY MAY 21, 1891, BY DR. WM. H. WAHL.

Mr. President and Gentlemen of the Institute—I propose to invite your attention in the following remarks to the consideration of the possibility of cheapening the cost of producing aluminium by improvements in chemical processes.

It is obvious at the outset that the selection of the aluminous compound to serve for reduction is of the highest importance. The compounds available for the purpose are three in number:

1. The halogen compounds (chloride, fluoride, etc.).
2. The sulphide.
3. The oxide.

Thus far, the compounds first named have been the only ones that have yielded satisfactory results on the commercial scale, and it would seem probable that if a substantial advance in the metallurgy of aluminium may reasonably be expected, it should be looked for in connection with these compounds that have heretofore proved to be the most pliable in the chemist's hands. It will be most instructive, therefore, to examine the processes, based on the use of the halogen compounds of aluminium, and to endeavor to ascertain to what extent the economies already realized in practice bar the way to further improvement.

These processes, which held the field alone until driven from it by the remarkable development of the electrical methods, are based upon the reduction of the chloride or fluoride of aluminium by means of sodium. For practical purposes it is found preferable to employ, in place of the simple chloride or fluoride of aluminium, the corresponding double salt of sodium.

First in order let us consider the Deville-Castner process. This embraces three operations—the manufacture of the double chloride of sodium and aluminium, the manufacture of sodium, and the reduction of the double chloride by sodium.

The statement will not be questioned by chemists that the use of the chloride as the aluminous compound to be reduced, is attended with difficulties. It cannot be produced in the wet way, either by precipitation or by the evaporation of its aqueous solution, and a roundabout furnace process is the only method by which it has thus far been produced commercially. Furthermore, it is so readily decomposed that it must carefully be preserved from the access of moisture. Also, though its reaction with sodium takes place with great energy, it has been found practically impossible to obtain by its use more than about 75 to 80 per cent. of the contained aluminium for physical reasons inseparable from the conditions under which the reaction occurs.

Its advantages are, its ready fusibility, in consequence of which the reaction with sodium begins at a comparatively low temperature, and the fact that it may be obtained entirely free from silicon and almost free from iron, the two elements that exert the most deleterious influence upon aluminium.

It is a just tribute to the skill and ingenuity displayed by the able chemists in charge of the Deville-Castner plant, at Birmingham, to give them credit for having succeeded in reducing the cost of sodium aluminium chloride from about 22½ cents (which is believed to be a fair estimate of its cost before the improvements of Webster and Castner) to about six cents per pound. You will, doubtless, have heard much of the claims of several processes for the direct production of the chloride, by passing gaseous mixtures containing chlorine and carbon over heated alumina contained in retorts suitably connected with a condenser. By one of these, described in Richard's admirable treatise on aluminium, the cost of production is affirmed to be as low as one and a half cents per pound. By another process, which is exceedingly plausible, hydro-chloric acid vapors are passed into an electric furnace, in which aluminium is being decomposed by carbon, the chloride formed being condensed in a suitably connected chamber.

Either of these plans, so far as one may form a judgment from their general features, appears to possess decided advantages over the older one employed in the Deville-Castner operations. Thus far, however, none of them, so far as I am aware, have been put in practice on the commercial scale, and, promising as they appear to be, I incline to the belief that the fluorides present such advantages, that if there shall prove to be any future for aluminium processes based on the use of sodium as the reducing agent, the fluoride compounds of aluminium and not the chlorides will be used for the purpose.

The reasons for this opinion are: The fluorides are absolutely stable at common temperatures; they may be highly heated without suffering notable loss by volatilization, and, by employing proper precautions in bringing the reducing agent in contact with them, they can be made to yield very nearly the theoretical quantity of contained aluminium in condition to be at once and without further manipulation cast into ingots.

Respecting the comparative cost of the chloride and fluoride of aluminium, while reliable data are wanting, I am confident that the opinion of chemists who have given the subject any consideration will incline in favor of the fluoride. There is this important advantage in its favor, that the resulting product from the reaction of sodium with aluminium fluoride, *i. e.*, sodium fluoride, by very simple and inexpensive operations, may be made to yield, on the one hand, sodium hydrate, which may be utilized for the production of sodium, and on the other hand, aluminium fluoride; thus regaining, at comparatively little cost, both the reducing agent and the aluminium compound to be reduced.

In the case of the chloride the end product of the reaction is sodium chloride, a substance of such little value as to be hardly worth the cost of evaporation and utilization. For these reasons, in the consideration of the future possibilities of the sodium process of producing aluminium, I believe the use of the chloride may safely be assumed to be impracticable.

We come now to the consideration of the remaining element of the chloride and fluoride reduction processes, namely, the question of the sodium. I am aware that the weight of opinion among chemists who have given the subject very careful consideration, is unfavorable to the future prospects of aluminium processes in which sodium is relied upon as the reducing agent. Richards, for example, whose opinion on all questions pertaining to the aluminium problem is entitled to the highest respect, in a lecture on this subject lately delivered before the Franklin Institute, says on this point: "I do not consider the sodium processes, however, as ever likely to take part again in the metallurgy of aluminium. I think their day is past."*

I will not venture to dispute the correctness of the conclusion to which this very able and conservative author has arrived, since there are other metallurgical methods that appear to be much more promising. The author I have just quoted, indeed, appears to be of this opinion, inasmuch as he says in the same paragraph, "* * * although electrical processes are 'on top' at present, and, I think, will stay there for some time to come, I am far from considering that they may not possibly be superseded by non electric methods of reduction."

It may be true that the sodium processes have had their day in the metallurgy of aluminium, but I am confident that the prospects for much cheaper sodium in the near future are decidedly brighter than those for cheaper aluminium. Without under-estimating the great difficulties involved in the production of sodium, and duly appreciating the value of the services of Deville, Castner, Netto and others who have contributed meritoriously to the problem of reducing the cost of its manufacture, I have been impressed of late with the belief that all the methods hitherto proposed and employed for the production of sodium are extremely crude in conception and imperfect in practice. For one, I think it would be entirely possible very greatly to reduce the cost of making sodium by the metallurgical way, but to do so, it must be manifest to all who are familiar with the past and present methods of manufacture that these will have to give place to others operated on some radically different plan.

My reasons for this opinion are briefly these: The cost of a metallurgical operation is largely affected by the scale of magnitude on which it is conducted; and, where heat is required to bring about the needful reactions, by the economy with which it is applied to effect the result, and, if it be furnace process, whether the operation is continuous or intermittent.

The capacity for production of a metallurgical plant increases in a much greater ratio than the item of labor cost; so that in such cases the doubling or quadrupling of the output may be accomplished with a correspondingly enlarged plant, with the aid of comparatively little additional labor.

Where heat is the prime element in reducing the reactions—which is practically always the case—those who have experience with steam power plants need not to be told how seriously the economics of a mill or factory are affected by the choice and proper installation of boilers and engines. In metallurgical operations the limits between economy and wastefulness in the application of fuel are much further apart. The question of economy, also, is materially affected by the manner in which the process is operated, *i. e.*, whether continuously or intermittently. A continuous furnace process, of which the blast furnace for producing iron affords us a typical example, realizes the highest attainable economy, and wherever it may be found practicable to adopt this feature of operation, the cost of the output will be notably reduced over processes worked discontinually.

Examining the sodium processes by the light of the foregoing statements, it will appear that none of them fully realize the conditions essential to the highest economy of operation. A few words of a critical nature upon the methods of Castner and Netto, which may stand for the most advanced sodium processes, will enable me, I think, to make it clear, in spite of the decided advance over previous methods which they exhibit, that from the metallurgical point of view they are very imperfect.

Castner, for example, operates on a number of small charges, introduced into a group of steel crucibles about 18 inches wide and 24 inches high, and capable of receiving a charge of 15 pounds of caustic soda and a suitable quantity of the reducing agent. The arrangements for removing a crucible from the furnace after its charge has been delivered, clearing it of the residuum, recharging and returning it to the furnace, permit these operations to be effected in about two minutes, so that the vessel still retains a good red heat when restored to its place for a second operation. The crucibles are heated by producer-gas.

The theoretical yield of a single charge of the above-named quantity should be 8.62 pounds; the actual yield in current practice at the Oldbury Works, near Birmingham, according to Mr. J. MacTear, who has reported the results of a very thorough examination of the process, is 2.5 pounds or 29 per cent. A much larger yield, approximating to the theoretical quantity, has been obtained, but this cannot be realized in practice because the extremely high temperature demanded for it would result in the rapid destruction of the crucibles.

The great advantage of Mr. Castner's process over older methods lies in the fact that, by the employment of a special reducing agent (an intimate mechanical mixture of coke and carbide of iron) he is enabled to operate upon caustic soda, which may be reduced by carbon at a much lower temperature than the carbonate. The inventor has claimed that by this process the cost of manufacturing sodium on the large scale will not exceed 25 cents per pound. Mr. MacTear has named the result of his experimental work at the Oldbury establishment, 16½ cents (8¼ *d*).

I have no data at hand from which to determine how nearly either of these estimates is actually realized in current practice. I can only say that the price at which the product of the works is quoted on the market will yield the manufacturers 200 per cent. profit on the price named by the inventor.

Dr. Netto's process, in the opinion of competent judges, is the most economical method that has yet been put in practice, nevertheless, like that of Castner, it fails to realize, save in one important feature, the conditions of highest economy that I have assumed to be essential in a metallurgical operation.

In order that the bearing of this criticism may appear, it will be well to present a brief description of the process for the information of those who may not be familiar with it.

Dr. Netto uses a cast-iron retort, about three feet high and two feet in largest diameter, lined exteriorly with fire clay, and placed vertically in a furnace in which it can be heated to the desired temperature. The flames of the furnace, after passing around the retort, may be directed laterally so as to pass beneath an iron pot supported above the retort and to one side of it.

This pot is supplied with caustic soda, kept in the state of fusion by the waste heat of the furnace, and provision is made for feeding the soda in a regulable stream into the retort at the proper time. In connection with the retort there is a condenser for the sodium, and also a trapped pipe at the bottom through which the accumulated carbonate may be allowed to pass out of the retort.

The retort is charged at starting with 50 kilos (110 pounds) of charcoal or coke, and when this has been brought to bright incandescence, the valve controlling the access of the soda is opened and the fused alkali is permitted to flow into the retort and upon the glowing carbon. The reaction begins at once, and the sodium, distilling over, is caught in the condensing chamber.

The feed of the alkali is controlled by an attendant, who judges of the quantity to be admitted by the appearance of the flame of the gases, which burn at the outer orifice of the condenser. The process goes on continuously until the charge of carbon in the retort is nearly spent, the heat abstracted from it as the reaction proceeds being restored by the heat supplied to the exterior of the retort from the furnace, which is kept constantly fired.

When the carbon in the retort shows signs of exhaustion the flow of soda is checked, the retort is charged afresh with charcoal, and when this has been brought up to the right heat the operations just described are repeated.

In Netto's process, as in Castner's, it is found necessary, in order to avoid the rapid destruction of the retorts, to maintain the temperature of the retort and contents only slightly above that required for the decomposition of sodium hydrate by carbon, which requires only a full red heat to deliver sodium freely, and has the economic advantage of permitting the use of crucibles or retorts of cast iron. The reaction of sodium hydrate, however, as I have already intimated in the consideration of Castner's process, is not complete, but according to the heat of the charge, and to some extent, perhaps, by the manner in which the component parts of the charge are brought into contact, a varying proportion of the hydrate is always converted into carbonate, which can only be decomposed at a temperature approximating that of white heat.

In Castner's process the yield of soda, as we learned, is about 30 per cent. of the theoretical; in Netto's it amounts, according to the most reliable data I have at hand, only to 20 per cent. It appears, therefore, that 80 per cent. of the sodium charged into the retort in the form of caustic soda, is converted into carbonate. This carbonate, after the operation of the retort is once established, is permitted to discharge itself automatically through a siphon, provided at the bottom, and, after re-conversion into caustic by treatment with lime, is ready to serve for another operation.

The advantage of Netto's process, as compared with Castner's, lies in the fact that the former is continuous—at least approximately so—a feature which permits of a large saving in the cost of labor for the same amount of output, since it dispenses with the frequent withdrawal, cleaning out, recharging and returning of crucibles to the furnace, incidental to the latter; furthermore, the conditions under which the Netto process is operated are, other things being equal, more favorable to the economical use of the fuel. Nevertheless, so thoroughly is every detail of the Castner process carried into practice, that the cost of production by the two processes is probably almost the same. I have no possible information as to the actual cost of sodium by Netto's process, but if the selling price may be considered as a reliable indication, the opinion just expressed is substantially correct.

It may be unwarranted, in the face of what has already been accomplished in this branch of the chemical industry, to anticipate still further and greater advances in the direction of diminished cost of production, but the recent history of aluminium should prove a warning to him who may be inclined to pay the role of Sir Oracle; and this warning applies, in my judgment, with special force to the sodium problem, as I will endeavor to show.

As comparison is the most instructive form of illustration, I will ask your attention to the following parallel, by which I wish to exhibit how very wasteful the present representative processes for sodium appear; and also by comparison with other metallurgical processes, how far we should be able to improve upon them by the intelligent application of well-known principles; to wit:

Starting from the reaction which most clearly represents what takes place in the retorts of Castner and Netto, namely:

$$3Na\,O\,H + C = Na_2\,C\,O_3 + 3\,H + Na,$$

and, assuming that the partial conversion into carbonate of the sodium contained in the caustic and the liberation of only one-third of the metal at one operation, afford practical advantages on account of the moderate temperature at which the reactions take place, the following conclusions may be stated.

The molecular weight of the 4 NaOH in the preceding formula is 120; that of the carbon 12 (or 10 to 1). Assuming that the heat necessary to cause the foregoing reactions to take place, has been supplied, one pound of carbon interacting with 10 pounds of caustic soda (containing 5.75 pounds metallic sodium) should yield 1.92 pounds sodium metal and 3.83 pounds sodium in the form of carbonate.

(The value of this carbonate should properly be credited by deducting it, less the cost of re-converting into caustic, from the cost of raw material. This credit will appear later.)

As that portion of the reaction which results in the production of the carbonate is exothermic (*i. e.*, one which liberates heat), its influence on the question of the heat involved may be ignored.

One pound of carbon at the temperature of reduction yields in round numbers two pounds of sodium. To this must be added the carbon necessary to heat the retort and its contents to the reduction temperature, and to maintain it at that temperature while the reaction is taking place. The conditions of practice are so complex as to render any theoretical estimate of this factor of no value. We shall be quite safe, however, in accepting as a guide the figures actually ob-

* Richards.—The Aluminium Problem.—Journal Franklin Inst., March, 1891.

tained in practice, in the reduction of another oxide with carbon, *i. e.*, the oxide of iron, the data concerning which have been so carefully observed that we can hardly go astray.

In modern blast furnace practice one pound of carbon suffices for the reduction of one pound of iron. The reactions in the iron furnace may be explained by assuming, first, the formation of carbonic oxide by the union of the carbon with the oxygen of the blast, thus:

$$3C + 3O = 3CO;$$

and the formation of metallic iron by the interaction of this carbonic oxide with the ore, thus:

$$Fe_2O_3 + 3CO = Fe_2 + 3CO_2.$$

Whether this expresses correctly the course of the reactions within the blast furnace, or, whether the reduction of the oxide of iron is effected directly by the carbon, is a matter of indifference for the purpose of my illustration, since the final result, *i. e.*, the reduction of a metallic oxide by carbon with the aid of artifical heat, is the same in the case of both iron and sodium.

Now, proceeding with the iron reaction, as I have previously done with sodium, theory requires that 36 pounds of carbon at a certain heat shall reduce 160 pounds of ferric oxide, yielding 112 pounds of metallic iron. One pound of carbon should, therefore, yield, say, three pounds of iron. Now, one pound of carbon, it will be remembered, actually suffices for the reduction of one pound of metallic iron, or approximately one-third of the amount of metallic iron which theory demands.

It follows, therefore, that for every pound of carbon usefully consumed in the reduction process two pounds of carbon are consumed in heating the charge or the furnace to the temperature at which the reaction between the residual carbon and the ferric oxide will take place.

The comparison between the economy realized in the production, respectively, of iron and sodium may now be instituted with instructive results.

As previously pointed out, theory demands that one pound of carbon at the temperature of reduction shall yield from caustic soda, two pounds of sodium.

From the figures of fuel consumption in the published accounts of Castner's and Netto's processes, I have been able to make the following estimate, viz.:

Castner obtains one pound of sodium with a consumption of 14 pounds of fuel.

Netto obtains one pound of sodium with a consumption of 11.6 pounds of fuel.

Averaging these results, it will appear that one pound of carbon yields in practice approximately one-twelfth of a pound of sodium, where theory demands two pounds. The conclusion is at hand, therefore, that of the 12 pounds of carbon required for one pound of sodium, $\frac{23}{24}$ (or 11.5 pounds) are consumed in the work of heating and maintaining the retort and its contents to the temperature of reduction.

The iron furnace, as previously calculated, requires but two pounds of fuel for this work, therefore, the latter is approximately six times as economical in respect of heat utilized than the sodium furnace.

This comparison, I believe, is a fair one and the conclusion is justified therefrom that, by the application of heat with the same economy that is realized in blast furnace practice, the cost of sodium could be reduced to about one-fourth of the present figures.

Taking MacTear's estimate of the cost of the Castner process, namely, $8\frac{1}{4}d.$ ($16\frac{1}{2}$ cents), and allowing $2\frac{1}{2}$ cents per pound as a standing charge for the caustic, the fuel saving indicated above would bring the cost of the metal to the very low figure of five cents per pound.

Assuming, now, that we operate on an aluminous fluoride with the cheap sodium just obtained, the final products will be aluminium metal and sodium fluoride. From the latter product, by a process like that of Herr Grabau, of Hanover, or by several other available processes analogous to it in general features, the aluminous flouride, almost chemically pure, may readily be regenerated, thus offering the material for the continued operation of the reducing process and at a cost, I feel assured, that will compare favorably with that of anhydrous alumina prepared from beauxite, which is the source of the aluminium manufactured by the electrolytic methods of Hall, Minet and Herault.

Furthermore, a simple series of reactions could readily be made available, by which not only the fluoride would be regenerated in the form of aluminous fluoride, but the sodium also would be recovered in the form of caustic soda, which last would furnish the raw material for the production of more sodium.

Allowing for the unavoidable losses in operations of this kind conducted on the large scale, it is not an extravagant estimate to assume that 75 per cent. of the sodium could thus be recovered after it had served the purpose of reacting on aluminium fluoride.

The regeneration of the sodium by some such method as I have here outlined, I need scarcely add, would mean another notable reduction in the cost of sodium metal, since it would mean supplying a large proportion of the raw material needful in its manufacture at less than one-half of its market price.

As caustic soda represents very nearly 50 per cent. of the cost of manufacturing sodium by present methods, the effect of such a saving as this would be to reduce still further the cost of the sodium operation. Assuming that this item of saving represents one-fourth of the cost of manufacture, the figure previously named (5 cents) would be reduced to $3\frac{3}{4}$ cents.

The realization of these economic conditions on the industrial scale, of the feasibility of which I feel assured, would place the metallurgical methods again in a position to compete advantageously with the electric.

On the basis of these facts and inferences, let me present you with an interesting comparison.

Capt. Alfred E. Hunt, in a leeture recently delivered before the Boston Society of Arts, gave an estimate of the probable cost of manufacturing aluminium by the electrolytic method practiced by the Pittsburgh Reduction Company, of which he is the head. This estimate is based on the assumption that the manufacture shall be conducted on a scale of much greater magnitude than at present and with the cheapest source of power, namely, water power.

Apropos to this estimate of Captain Hunt, I wish to remark that it has afforded me a most interesting subject for study, and I desire here to declare my conviction that it is in no single item exaggerated on the side of economy. Respecting one of the figures named—that of the cost of water power—I entertained at first some doubts as to its accuracy, and to satisfy myself on the point I presented the inquiry to my friend. Prof. Coleman Sellers, an engineer of wide experience and at present one of the board of consulting engineers to the Cataract Construction Company, which is engaged in the important work of utilizing on a grand scale the water power of the Niagara Falls.

I will take the liberty of quoting to you from a letter which I received from him some data covering the subject of my question:

"Almost all the existing examples of water power are dependent upon accumulation of water in reservoirs created by erecting dams across existing rivers and so accumulating water and distributing it by canal to the water wheels, as at Holyoke, Lawrence and our own Schuylkill River. The water power, for instance, of the Schuylkill and sold by the Schuylkill Navigation Company, was quite limited in its amount and is already exhausted, and it may be assumed to be somewhere in the neighborhood of $30 or $35 per horse-power per annum for day use only.

"These water powers are generally sold either by day use or by 24 hour use, and for the purpose of metallurgical reductions it would probably be required on the 24 hour basis.

"The difficulty about getting at the cost of these water powers is the uncertainty of the continuance of the dams that are built to retain the water. These are liable to decay and deterioration, and sudden freshets often destroy them entirely, involving heavy costs that are not known until the event occurs. The exceptional case of Niagara presents an absolutely unfailing water power that does not vary the year round. The difficulty in the way of its use, however, consists in the extreme width of the breast of the dam and the necessity for carrying the water through a long surface canal to the lower chasm where it is to be used, or the digging of the tunnel as a tail-race to carry away the water that has been used from the wheels or other motors.

"A canal was built about 40 years ago which is still in use, that carries about 6,000 horse-power to the lower river, but this amount of power has already been more than exhausted by users who availed themselves of it, and its further extension by that method would be very costly.

"The present scheme of utilizing Niagara Falls by the company in which I am interested, is by means of a tail-race tunnel under the town of Niagara, and the preliminary work now being done, when completed, in about a year, will throw into the market about 120,000 horse-power that may be said to be absolutely permanent and endurable, and capable of being worked for 24 hours in the day.

"It is premature to say what this power will bring in the market, but it is the only example I know of where water power can be counted on as absolutely stable and not liable to any disturbance or delay, and where the price will be comparatively low.

"I should think that you might safely say that it presents the possibility of power being obtained at less than half of what it would cost in any other known case, taking into consideration all contingencies. Small amounts of power may be obtained from streams of water of a reasonable degree of stability and far away from existing markets as low probably as $4 or $5 per horse-power per annum, but this is subject to the risk before mentioned.

"It is not alone the mere cost of water power that must be considered, but in a case like this it is the continuance or permanency of the power that will give it its value, and that power will be the most valuable that is liable to the least fluctuation, either in quantity or cost.

"I do not think, however, that it will be safe for you to predicate the value of metal produced upon anything short of about $15 per horse-power per annum, for 24 hour power, and that in very large quantities, while perhaps $20 per horse-power per annum would cover all contingencies."

Taking the estimate of $20 per horse-power per annum as sufficient "to cover all contingencies," we would have as the cost of one horse-power per hour 0.238 cents (or, say, about one-fourth of a cent).

This would give for 22 horse-power $5\frac{1}{2}$ cents, and for 22 electrical horse-power, allowing 10 per cent for loss in the conversion, six cents. Captain Hunt allows five cents for his power, which, considering that the figure named by Professor Sellers is obviously intended to be liberal, I feel satisfied is a fair one. This item of Captain Hunt's estimate is the only one respecting which I have at any time entertained any doubts, and I have been so impressed, in reading his admirable lecture, with the carefulness and accuracy of his statements, and his evident desire to avoid any suspicion of exaggeration, that I am quite prepared to accept the other figures, which are based on the experience gained in the practical working of his company's plant.

Resuming the thread of my discourse after this slight digression, I beg your attention to the parallel to which I alluded. Captain Hunt's estimate of the capabilities of the electrolytic method of producing aluminium on the largest scale is as follows:

BY THE ELECTROLYTIC METHOD.

COST OF PRODUCING 1 POUND OF ALUMINIUM.

2 lbs. alumina (contains 52.94 per cent. Al_2) at 3 cents	$0.06
1 lb. carbon electrodes, at 2 cents	.02
Chemicals, carbon dust and pots	.01
22 E. H. P. for 1 hour (water power)	.05
Labor and superintendence	.03
General expense, interest and repairs	.03
	$0.20

In presenting, by way of comparison, the possible figures of a metallurgical method, conducted on the same extensive scale and on the lines of my previous comments and explanations, I will assume that the cost of the last two items of the foregoing estimate will be the same, an assumption which may be made with safety.

Referring now to the preceding data, we will have:

BY THE METALLURGICAL METHOD.

COST OF PRODUCING 1 POUND OF ALUMINIUM.

$3\frac{1}{4}$ lbs. Al_2F_6 (containing 32.7 per cent. Al_2) at 3 cents	$0.09¾
$2\frac{1}{4}$ lbs. sodium, at $3\frac{1}{4}$ cents	.09⅜
Labor and superintendence	.03
General expenses, interest and repairs	.03
	$0.25⅛

I think that I have presented in the foregoing, the capabilities of the sodium process within entirely reasonable bounds. I admit, however, that I have made the best possible showing for the metallurgical side, except in respect of the last two items, in connection with which metallurgical operations should show an appreciable advantage over the electrolytic, and may bring the totals of the two estimates practically to an equality.

The second available compound named as a possible source of aluminium by chemical methods is the sulphide, including therein, of course, the double sulphide with sodium or other alkaline metal. I refer to it only because of the fact that its use for the purpose was originally suggested by one of the ablest chemical engineers of our day, the late Mr. Walter Weldon. Thus far, however, nothing has been accomplished with it, and, though it may be possibly made to serve to advantage in electrolytic methods, I am satisfied that the probabilities are very slight, indeed, that it will ever prove sufficiently useful as a source of aluminium, to be able to compete with other chemical methods.

Not only is its manufacture attended with unusual difficulties, but its reduction also, so far as I am able to judge from personal experience, cannot be effected as readily as that of the chlorides and fluorides, and the resulting product is much less pure than that obtained from the other aluminous compounds just named.

The sulphide, I believe, is much better adapted for the production of aluminium alloys than for aluminium, but the difficulty of obtaining the product free from serious contamination is probably the reason why the sulphide method has never made a record for itself.

I consider the case of the sulphide from the metallurgical point of view to be so impracticable as to be hopeless.

The third available aluminium compound which the chemist may hope to make available as a source of cheaper aluminium is the oxide. Considering the subject from the chemical standpoint, I am persuaded that the attack upon the problem, with this compound as a starting point, offers even greater possibilities of ultimate success than the sodium and fluoride method we have just passed over, and for the reasons, that it involves the possible application of the cheapest of all reducing agents—carbon—in the production of the metal, and the employment of much more direct methods and simpler and less expensive apparatus than is demanded by the method with sodium.

The fundamental fact that alumina can be reduced to the metallic state by carbon, is established. It is proved beyond peradventure by the operation of the electric furnace of the Cowles Bros., in which heat, developed by the transformation of electric energy upon the passage of the electric current through a fragmental resistance material of carbon and alumina (with copper or other metal present as a solvent), is believed to be the principal agency in affecting the reduction. The same action may probably take place, to some extent, in the operation of the Herault furnace, and certainly does so, if the statement can be verified that the output of this furnace is greater than can be accounted for by simple electrolytic action.

The reduction of alumina by carbon, therefore, may safely be stated to be simply a problem of temperature, and this temperature is probably not far above the fusion point of alumina. This, unfortunately for the practicability of the direct reduction process, lies enormously high, so high, indeed, that it does not admit of instrumental measurement, but can only be approximately estimated as somewhere between 2,000 degrees and 2,600 degrees C.; a point which cannot be reached, save by the intervention of electric heating.

There is an alternative, however, that offers a ray of hope to the chemist. There are other methods besides that of fusion for obtaining alumina in the state of a liquid. We have, at least there are very good reasons to believe that we have, solvents for alumina, and if the condition of fluidity is as important a factor as it is believed to be in inducing chemical reactions, we have the possibility open to us of establishing conditions favorable to the reduction of alumina by carbon at temperatures, perhaps, far below the fusion point of alumina.

The fluorides of the alkalies and the alkaline earths, we have reason to believe, dissolve alumina freely, and there are other compounds into which alumina enters that may be dissolved in the proper menstrua.

Here is the vulnerable spot in the armor with which that intractable substance is surrounded, and by concentrating his attack upon it the chemist may yet succeed in piercing it. Whether by this mode of attack he will be able to produce aluminium directly is gravely doubtful in the light of our present experience. I can only affirm my belief that the thing is within the range of possibility. On another point, however, I can speak more confidently, namely, as to the practicability of producing the alloys of aluminium by some such method. Of this I have not the slightest doubt. I will go even farther, and venture a prediction that in the near future the alloys of aluminium will be produced at least as cheaply by chemical methods as by the present electrical methods.

I have now passed over the ground, though hastily, that I had mapped out for my discourse upon this most fascinating technological problem. I have thought that by presenting the aspects of the problem from the chemist's standpoint, the subject could be made more interesting to a representative body of electricians, such as the one I have the honor of addressing.

Briefly summarized, the case stands thus:

The processes in which electricity is applied, either for the direct reduction of aluminium by electrolysis or as the agency for producing the heat required to effect its reduction by chemical reactions, have outstripped the metallurgical methods in the race for supremacy and have taken a decided lead.

Within the past two years the metallurgical processes, as represented by the improved methods of Castner, Netto, Grabau and others of less renown, have been forced to abandon the field to the electrical methods of Hall, Minet, Cowles and Herault.

In one brief lustrum to have overtaken and gained the mastery—though it should prove but temporary—over a champion so redoubtable as the chemist, who has been striving for the glittering prize through half a century of toilsome progress and indifferent success, is an achievement of which the electrician may well be proud. It behooves him though to look well to his freshly-earned laurels, for his victory will stimulate his rival to renewed exertions.

But let our sympathies incline this side or that, if the outcome shall be—and I am persuaded it will speedily be—the final solution of the aluminium problem, we may rejoice in common, for in the victories of peace the vanquished share with the victors in the spoils of the battle.

I thank you, Mr. President and gentlemen of the Institute, for your patient attention.

Discussion on "Practical Aspects of Electric Welding," by Dr. F. A. C. Perrine.

Prof. Elihu Thomson: My time has not been very closely given lately to the applications of welding processes in the arts. That department of the work has been very ably taken care of by Mr. Lemp, whose paper the Institute heard last year. Of course, I have inspected the machinery as each type was brought out, and made suggestions constantly on this or that point, and may be considered, therefore, as a sort of privileged observer of results. There are gentlemen here also who may be able to give you more information in regard to the development of the business than I. I would say, however, in general, that the tendency in the development of electric welding seems to be to produce new processes or to give rise to new applications of mechanical principles such as are seen in the wheels before us. There we have practically a development of a system of work depending entirely upon electric welding, and that seems to be the direction in which it is to grow most rapidly. Naturally, when it comes to supplanting ordinary processes of welding, there is that inevitable prejudice to overcome, and at the same time the reluctance of the manufacturer to throw aside a plant which he already possesses, and which does his work in a sense, going to something entirely new, putting in an extensive electrical plant which he is afraid of, for fear, perhaps, that something may happen to it and it may require repairs. He prefers that his neighbor shall get all that kind of experience before he takes hold himself. That is very natural, indeed, and it simply means that in certain directions the electric welding operations will probably be slower than they would otherwise be. But with the special cases, many of which you have had mentioned in the able paper presented, you could see for yourselves that there is a direct and easy growth.

In relation to the wheel in which the cast hub is joined to spokes, there is one point I might mention, that the possibilities are very well shown in that wheel of performing a number of welds at one operation. There we have the spokes set in place in the machinery and radiating towards the hub, and the machinery grasping the spokes separately, welding them all at one application of current, so that we have a number of welds all in multiple, as it were. The other case is an excellent example of a different procedure where the spokes radiate toward the center, and are caught, as it were, and pinched between two surfaces which are being welded and are, therefore, securely fastened. These are isolated examples of what processes are capable of being performed by the new art.

In regard to the changes of structure which are undergone by materials subjected to the welding process, that was, of course, noticed rather early. It was particularly prominent in the case of hardened steel, which underwent a decided change during the welding. It would naturally be expected that whatever change was due to the application above a certain heat would be found in this metal at the weld. It would also be naturally expected that such action might proceed back from the weld a certain distance, or, in other words, that if this had been tool steel that had been made under the hammer or in rolling and had been given a certain texture by that mechanical knead or by the hammer, that a relaxation of that texture or a change of that texture might occur for a certain distance on each side of the weld. That is an actual fact. A tendency to granulate, of course, comes there. The old idea was that the steel was burnt, but I have tried this operation in a hydro-carbon atmosphere, and it occurs just as well in a hydro-carbon atmosphere, so that it is not a burning process. It is not a burning operation. It is simply the relaxation of the molecules, the change of physical condition, or, perhaps, the chemical combination brought about by the high temperature. To a certain extent that action occurs with other materials, and, of course, with fibrous drawn copper it is the case.

Any metal whose properties depend upon the working, any metal a portion of the strength of which is due to having been drawn or hammered, of course, undergoes that relaxation or rearrangement or tendency to granulation, such as is found in a casting where the metal has undergone the melting process and has been allowed to cool afterwards. It is also a noticeable thing that we can take a bar of wrought iron and put it in the welding clamps and pass a current through it, heating the ends and carrying it to such a temperature beyond the welding temperature as will actually change its nature. It can be made by carrying it to a sufficiently high temperature to be a spongy burnt mass as we might call it. That is, the temperature has been made so high that the iron, like the steel, undergoes a change of condition and does not return on cooling. I attribute that largely to the fact that in the ordinary operations of the working of the iron the temperature has been below that point; that is, the iron has been made below that point in the furnace operations and that when we raise the temperature beyond the point of the making of the iron, we set free occluded gases which have been in the iron. We make the iron puff out as it were in a spongy form, by setting free the hydrogen gas between the fibres or at least in the substance and, consequently, the iron breaks very easily there, and we find that it is full of minute cavities which show that the occluded gases were removed.

Another feature of the welding operation has been mentioned which is interesting, which is that some materials when put together do not mutually yield during the heating; one as it were overlaps the other—the reverse rivetting as it has been termed by Dr. Perrine. One melts or softens and slips over the other. For many purposes that is a very strong joint, particularly if the burr or expansion is not removed. There has been no change of form or very little change of form of one bar. To be sure, if the enclosed bar does not change at all the union may be a perfect one. It may be that the outside piece in fusing over the other has brought just the same intimate relation of molecules of one and the other bar as though this had undergone a deformation or change. But in most cases it would naturally be expected that the best joint would be produced by, as it were, bringing to the front new molecules, perfectly clean and unchanged molecules, from the interior, in contact with the molecules of the other bar which are also spreading and moving, and that is actually true. Advantage has been taken in a few instances of this kind of action to make a joint by cutting a number of steps in one metal and causing the other, as it were, to dovetail itself by a simple flowing over, and that in some instances makes an excellent joint. The metal flows over and fills all around, and if it has any tendency to unite, such as brass and iron have, or brass and steel, of course, the union is very strong. We have all this surface and the tensile strength of this ring which may be steel—say that is steel and that brass—the brass filling the cavity, or in other cases it may be reversed.

Another point in relation to the practical application of electric welding and then I am through; and that is it is curious to notice how prejudice stands in the way sometimes of the best results. There are undoubted cases where the burr or extension left by the welding operation would be best left on, because there is an increased section there and unless this is going to be very well and heavily forged, the strength through the weld will be greater, and the bar will rarely, if ever, fail through the weld, but from the mere habit of not seeing things done that way where that extension would not do any harm if allowed to remain, people want it removed. It could in many cases be forged up to form a handsome bead, but in most cases it must look like the ordinary scarfed weld or it is not altogether marketable. That, I think, is a temporary condition for many cases of welding. It will be gotten over finally. Dr. Perrine has brought out that fact in relation to the telegraph wire, where formerly they were content to take the double twist joint with all the metal which is involved, and when they got this to take the place of that they were not content. Their self-induction was high and nothing would satisfy them but that that should be removed, which was, of course, a simple thing to do, either by forging it down or grinding it off.

One further point in relation to the upsetting for copper, the structure of which has been changed. This might represent a copper joint made on rather large copper. Now, naturally, if that joint has been formed the copper has been heated back here some distance on account of its high conductivity for heat, and if that part of the metal has a structure due to mechanical working that structure is partly lost, if not entirely lost, at this point. It is desirable on account of the resistance to strains required for some purposes that it should be restored. I found in the early days that I could swell up by taking the clamps apart a little, swell up a certain amount of material, and then hammer the mass down to its original condition. But when that comes to be attempted in rather large stock you can readily see that the power required is considerable. We must be able to take hold of that bar very firmly indeed, and we must have hydraulic pressure without any slipping to force up a mass of material at a rather low temperature, because if you heat it to too high a temperature the difficulty is that you do not upset the spoke far enough back; you require to take in almost the cold metal in the upsetting process and then forge it back to the original shape when you get the fibrous structure put back. That probably can be done by taking hold of a sufficient length of bar each side and putting guides on each side of the work, so that it will not buckle out of shape and take hold; in other words, at a number of points by multiple clamps, and then force the metal up. If we should use notched clamps there is an objection at once because we do not want any injury done to the exterior surfaces. We have to use a smooth clamp, a clamp which will not bite into the material and change its surface. That would require another operation to remove the notches so that we would probably have to take a foot or more of the bar, plant it firmly in clamps fitted closely to the work, and then force, it risking the slip. Of course, we cannot get an end pressure on a bar which may be very long—may be 100 or 200 feet or more than that—and a very long coil also, so that we have to get whatever we get by hydraulic pressure and risk any deformation that takes place. (Applause.)

Mr. William Maver, Jr.: With regard to the causes that led to the objections to the burr left by the electric weld, in the case of the telegraph wire, and without knowing the exact cause in the case in point, I would suggest that it may have been due to the fact that the presence of the burr prevented the free uncoiling of the wire in the act of stringing on the poles. In the case of hard drawn copper wire, this was one reason that led to the companies to forbid the use of any "splices" in the coil. Another reason was that factory "splices" were found to conduce to breaks in actual service. Still another objection to a certain form of sleeve joint was that it facilitated permanent crosses between wires that otherwise would only have been swinging crosses.

Mr. Lockwood: In common with others of the audience I have been particularly interested in this subject. It often occurs, I find, that different paragraphs in a paper of this character will impress different minds in a different way, and the paragraph which made the most impression upon my mind was that in which the union of two pieces of gutta percha was referred to. I find that this paragraph reads:

"Welding in the ordinary sense on an anvil by means of a forge, is essentially the uniting of two surfaces of a metal which has previously been rendered plastic, and which under the hammer can be made to intermingle into a structure similar or identical to the original metal; in consequence, this can only be accomplished with materials capable of passing into a plastic state before actual melting takes place. One of the most familiar examples of this weld to electrical men, is the common splice in the gutta-percha core of a submarine cable."

I suppose that splice refers to the copper part of the gutta percha core, but I do not know but that it refers to the gutta-percha part. It might apply to either, I suppose, with perfect propriety. It goes on to say:

"Provided only that the surfaces are clean, it is possible to make this material unite as perfectly as before it was cut. Amorphous waxes and similar substances can be treated by a like method, but when we reach truly crystalline materials it is no longer possible to effect this union below the melting point, unless great pressures are applied."

Mr. Chairman, in one period of my checkered career I was engaged in making plate glass. It is rather difficult for me to decide under which of these classifications glass comes. Whether it is a material that passes into a plastic state before melting takes place, or whether it is amorphous wax or similar substance, or whether it is a truly crystalline material. I have seen it in conditions which all approximated to either one of those conditions. It certainly does before it melts become plastic. I would like to ask whether the gentleman who wrote this paper can tell us whether anything has been done in working glass by electricity, and whether that has come within the realm of his operations, or whether it is likely to. It is very difficult, of course, to imagine how you can get glass to be acted on by electricity, but there are so many things done by electricity nowadays, and so many more things claimed to be done, that I should not be surprised if that comes in one or the other category.

Dr. Perrine: I think I submitted in the paper that it was not practically impossible to melt anything from a steel shaft to a bar of magnesium.

Professor Thomson: A tube of glass slipped over a platinum wire and the glass heated so that the glass came down and struck the wire. But in the ordinary operations of the work of incandescent lamps, glass is sometimes rendered plastic, as we are quite well aware, and sometimes the heat from the filament itself, touching the side of the glass softens it and the glass bulges out and makes holes sometimes. That, I think, must be taken as an instance in which electricity has got something to do with working glass the wrong way.

Mr. Lockwood: In New Albany, Ind., in the year 1869, there was a window plate glass works built, and I found that the only way known at that time of cutting off the end of the cylinders which were first blown to eventuate in window glass was to take a portion of glass from the pot on the end of a blow pipe and twist it around the end of the cylinder for a moment, and then take it off and drop a little water on the place where the melted glass had been and the end of the cylinder would then crack off at once. The cylinders were then placed in the flattening oven. Before placing them in the oven, though, they were run with a red hot disk lengthwise. Then they were placed in the oven, and when they became plastic were flattened. Prior to that time my electrical knowledge had been gleaned by telegraphing. When I left the business temporarily I did not give up my interest in electrical work, and after watching the men taking the ends of these cylinders in the way they did, it struck me that a fine wire if heated by the passing of a current, might be used to take off the ends of the cylinders, and I invested all my spare means in a battery, and I got enough current to make an iron red hot. It worked like a charm. The glass blowers at that moment looked upon me as being something of a medicine man, and after doing it two or three times, I found that my means at that time would not enable me to keep it up, although the thing was done and done well. I speak of it at this moment simply to show that there was an application of electricity to the manipulation of glass, and I may further say that within the last decade, at least, some fellow has patented that process.

Mr. Weston: Mr. Lockwood's remarks remind me of the fact that I think Joule published a little account of a process of cutting glass some 50 or 60 years ago. It has been revived from time to time, and has, I think, as Mr. Lockwood says, certainly within the past few years been patented. We were in the habit of using it for several years for cutting off glass tubes in the chemical schools, and in very large numbers every day. We stretched a platinum wire in loop form over a piece of wood with a space between the portion dipped and with that we cut away our tubes, and cut all the extra length off the incandescent lamp globes for several years. We found it very useful, and, of course, having a large supply of energy at our hand it didn't amount to very much. I doubt, however, except in special cases, whether it would be of any great practical use.

Discussion of Paper by Milton E. Thompson, on "A Study of an Open Coil Arc Dynamo."

Professor Elihu Thomson: I called Mr. Thompson's attention in regard to the blowing out of the spark as expressing an erroneous idea in relation to the machine. This he would find expressed in Silvanus Thompson's "Dynamo Electric Machinery," and that the air space in the Thomson-Houston three coil machine is for the purpose of blowing out the spark. That is not at all the case and never was, and the air blast was introduced for no other purpose than to make it possible to run the machine steadily at high differences of potential with a commutator which could be freely oiled. It was found in the early experience with the machine that it was possible to construct a machine up to about 12 to 15 arc lamps which would retain the normal working condition without flashing over, as it is called—short circuiting across the slots and the short circuit being carried around. But beyond that potential difference there was an imminent danger of its occurring, although a 25 light machine might run for an hour or an hour and a half without any flashing or short circuiting over. Of course, the tendency to flash over increased with the difference in potential. Now, it was also desirable to run the commutator with a film of oil to freely oil the machine, and when the commutator was freely oiled, the limiting potential which could exist without flashing was much lower. Even a ten light machine might flash readily if there was a good deal of oil on the commutator. In the early days men would oil the commutator. It was almost impossible to keep them from taking an oil can and squirting on the commutator. The Brush machines were very sensitive also to this same action, and their recommendations were very distinct as to what was to be done to oil the commutator—that is, to take a rag and grease it with a little vaseline and touch the commutator lightly. If the commutator was thoroughly oiled there would at once be a flash. Another thing, the oil on the commutator, of course, diminished the wear, so that if there was any little roughening it was relieved a great deal from cutting and making copper dust around the commutator. I tried in the early days to get rid of the difficulty and did get rid of it

by using condensers on the machine. I took the three coils. I led our connections from each segment to a triple condenser. That preceded the development of the air blast. There were three coils in inductive relation. On a machine up to six or eight lights, I found I could actually obliterate the sparking at the tips of the brushes, and the brushes could be moved quite a distance without causing sparks while the machine was carrying its load. But I also found that the condenser was very subject to perforation. There were conditions arising which raised the potential enormously, and I could under certain conditions get static charges, and this is a very interesting matter, indeed, as looked at from the present standpoint in relation to alternating charges. From a single turn of the wire leading from the segment to the condenser coil, I could get discharges of an eighth of an inch from one to the other, a discharge which refused to run around the coil, in fact, through the double insulation of wire and the air space between, the discharge would snap across this point, and if it did not get a chance to do that it was very apt to go through the condenser coils. I tried to apply that principle to a much larger machine, and I found I could not make the condenser live under these conditions. It would perforate, although it was a remedy for the flashing. The tips of the brushes were practically quiet. It did not fulfil the conditions in practice, so that it lead to the trial of an air blast on the tips of the brushes, and the reasoning used in getting the air blast was this, that on the leaving of this segment there would be a small amount of current still fed from the segment to the brush, which would, as it were, tail off, and the sparks would be thicker at the brush and gradually thin out to a fine point and then stop. Then the segment would change polarity and go on to the other side. But, naturally, if the change of polarity was immediate on the cessation of that spark there might remain, as it were, from the spark, hot gas, which would enable the discharge to take place in the opposite direction, and that was a flash, which would be carried over from the arc. My idea was simply to blow a cold blast of air—as it were—to drive that spark away and insert, no matter how thin, a layer of cold air before the reversal was accomplished, and in that way to keep the insulation of the machine. That process is found effective even with a three coil commutator up to 3,500 or 4,000 volts with the pressure, of course, slightly increased as we rise.

Dr. Wm. E. Geyer: I have always thought that this machine is the most unique and interesting of all the machines built. I am very glad that a study of it has been made in this manner by Mr. Thompson. I should like to remark, however, that an exactly similar investigation was made as early as 1879 on a Brush machine of the class called open coil. The apparatus was just the same, a ballistic galvanometer being used, but instead of angles being taken every five degrees, they were only taken every ten degrees. The experiments were made more particularly to illustrate the action of any one particular coil, or of two coils in series, and, finally, of the machine as a whole. I might state that a short account of this was read at a meeting of the American Association for the Advancement of Science, at Boston, in 1880, and experiments were conducted by President Morton and Professor Thomas on some machines connected with the United States Light House Board.

Mr. E. W. Rice, Jr.: In connection with the remark Professor Thomson made, that the flashing of the commutator was due to the re-establishment of the arc across the segment by the hot gases, I think it would be interesting to state a fact which I believe is not generally known, but which we discovered at the Thomson-Houston factory while experimenting with large lights for government use, with currents from 50 to 100 amperes, the potential difference being 50 volts and run in connection with a machine that would produce about 75 volts. We found we could turn out the light and allow the arc to be completely extinguished for a full second; then switch on the current and the arc would be re established. This was done repeatedly, showing that the hot gas was sufficiently conductive to re-establish the arc where there was a difference of potential of not more than 75 volts.

Professor Thomson: I have seen that repeatedly where you could turn the switch and throw the current on again and the arc would re-establish itself, a complete dead space existing between the carbons for some interval. I would say just here, calling attention to the paper of Dr. Nichols, that we have an observation which goes along with this paper very prettily that here we have just the case of the stoppage and re-establishment, and the experiments mentioned prove that the alternations might have been very slow indeed and with a considerable interval of interruption.

Electricity in the Production of Aluminium.

BY PROF. M. G. FARMER, IN DISCUSSION OF A PAPER READ BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS BY ALEX. S. BROWN, NEW YORK, APRIL 21, 1891.

During the year 1859, while I was experimenting upon wires of different materials for the purpose of producing an electric light, I chanced to try a wire of aluminium. When the wire was well heated by the electric current, I noticed that the light given out by it approached quite closely in brilliancy to that given out by incandescent platinum. When I approached a steel darning needle to the wire loop, I saw that the wire was deflected, as any wire should be which carried an electric current in a magnetic field. Its behavior was different in this respect: A wire of platinum would retain much of its elasticity even when heated to a high temperature; not so with the wire of aluminium, it seemed to wholly lose its elasticity, and was as mobile or flexible as a string or thread. I do not know what, but something prompted me to puncture the heated aluminium wire, and when I withdrew the darning needle there followed it a stream of melted aluminium to a distance as great as one-quarter of an inch or more. I swung the loop but the wire did not fall apart, although it was fluid internally, but exteriorly it seemed coated with an oxide which retained its cohesion and supported the wire against gravity. I noticed that the wire after it had been heated and cooled once or twice, was shrivelled and appeared shrunken, like to a shed snake-skin.

My next experiment of promise was in 1856, when I deposited electrolytically some aluminium upon a copper wire. I also coated a German silver spoon with it and the plating was well done, and it wore well. This experiment led me to predict at that time that at some future date aluminium would be produced and sold profitably at 65 cents per pound. I was not so far out, for at this date, 1891, the Pittsburgh Reduction Company offers it for sale at $1.50 per pound, and an inferior quality at 90 cents per pound, although in 1856 I was obliged to pay $2.50 per ounce avoirdupois for the metal which I was using in my experiments. From the counter electromotive force apparent in the circuit, I was led to think that several crucibles or tanks arranged in series would be worked more cheaply than a single crucible or tank. My reasonings on this point led me, in 1885, to apply for a patent, and on April 7 of that year patent No. 315,266 was granted to me, which shows crucibles arranged in series in the circuit. About the year 1863, I commenced making experiments on alloys of aluminium with various other metals, such as copper, silver, zinc, tin nickel, cadmium, iron, etc. I patented two of these alloys, one of which, No. 38,301, covered the composition of an alloy which so closely resembled 18-carat gold as to deceive the most experienced dealers in that metal when judging merely by its looks. I made of this alloy watch cases, chains, thimbles, knives, forks, spoons, and some of these are now in good condition.

The second patent, No. 44,086, was for an alloy which should be adapted for sheathing metal for ship's bottoms, but the then price of aluminium was prohibitory. I made of this alloy keys, ship's nails, balls for grinding gunpowder without striking fire, and many other useful things. I had a blacksmith draw out one of these nails to double its original length without cracking it in the least, and although it was stretched from 2¼ to 4½ inches in length, yet it showed no flaw. I drove a nail which was 1¼ inches in length, into a block of lead its whole length without seriously bending or crippling it. I presume that at that date I compounded more than one hundred of these different alloys. I look upon the alloys of aluminium with other metals as a most promising field of investigation. I tested wires made from some of these alloys which did not break short of 130,000 pounds per square inch. The shrinkage of these alloys when cast is remarkable, and needs to be provided against. Among the many of these alloys which I compounded was one which had a peculiar "cry" when passing through the rolls, resembling block tin when it is bent, only that it was much louder, and it lasted as long as ten minutes, perhaps, and it could be heard at the distance of 75 to 100 feet.

I come next to the very interesting paper of Mr. Brown. He says in effect that there is at Boonton a dynamo weighing over 19 tons, which will, at an armature velocity of 220 revolutions per minute, maintain a current of 3,500 amperes under a pressure of 35 volts; of course, the total resistance of the circuit must not exceed .01 ohm in order for this current to be possible. This resistance must include the resistance of the crucible, plus that of the dynamo, plus that of the leading wires or conductors which complete the circuit. The distance of the dynamo from the crucible is stated to be about 14 feet, and the cross-section of these conductors is given as about four square inches; hence this leading wire resistance may be about .0008 ohm. He does not give us the resistance of the crucible nor its complete dimensions nor the specific resistance of the contents of the crucibles; all we can infer is that the total resistance of the circuit cannot exceed .01 ohm. Now, a current of one ampere can liberate .00114 pound of aluminium per hour, hence a current of 3,500 amperes can liberate not more than 3.99 pounds of aluminium per hour, or 95.76 pounds in a day of 24 hours, and it would require at least 164.1 horse-power to turn the dynamo while doing it, were the efficiency of the system unity; but as its efficiency probably does not exceed 90 per cent. it would require 183.75 horse-power for the liberation of the 3.99 pounds in one hour, or at the rate of 46 horse-power for the liberation of one pound of aluminium.

In a recent lecture delivered in Boston by Mr. Alfred E. Hunt, president of the Pittsburgh Reduction Company, he states that it requires about 22 horse-power to liberate one pound of aluminium per hour at their works, and he gives the production as not far from 500 pounds daily. Possibly even this is not the best attainable result. Suppose that we should employ four crucibles in series in the circuit, as illustrated in my patent, No. 315,266, issued April 7, 1885, each crucible having an internal resistance of .005 ohm. Suppose, further, that the dynamo and its leading wires should offer a resistance of .002 ohm, then the total resistance would amount to .022 ohm. Now, instead of employing a current of 3,500 amperes, suppose that the current should be reduced to 1,000 amperes, then our hourly production of aluminium from the four crucibles would amount to 4.56 pounds, or 109.4 pounds in a day of 24 hours. In order to maintain a current of 1,000 amperes in this circuit of .022 ohm resistance against a counter electromotive force of 14.28 volts, it would be needful that the dynamo should be able to produce a pressure of 33.28 volts.

Next, suppose that we put ten crucibles instead of four into the circuit, with a dynamo that has an internal resistance of .001 ohm, this includes the resistance of the conductors which lead from the dynamo to the crucibles; suppose, further, that each crucible with its leading wires should offer a resistance of .001 ohm, then our total resistance in circuit will be .011 ohm; suppose, also, that our current remains as before, 1,000 amperes, then our hourly production from the ten crucibles will amount to 11.4 pounds, or to 273.6 pounds in a day of 24 hours. To maintain this current of 1,000 amperes in this circuit of .011 ohm will require that the dynamo shall maintain a pressure of 39.2 volts, and the power required to turn the machine will be 58.8 horse-power, and the hourly production of one pound will require the exertion of only 5.15 horse-power, instead of 46, as in Mr. Brown's case, or 22 in Mr. Hunt's case. Even this economy can be surpassed if we attentively study the following equation: Let p=.0015 be the horse-power corresponding to one volt-ampere, allowing for an efficiency of 90 per cent. in the dynamo; let q=.00114 be the quantity of aluminium liberated in a crucible in one hour by a current of one ampere; let N denote the number of crucibles arranged in series in the circuit; let C denote the strength of the current in amperes; let V denote the pressure in volts exerted by the dynamo; let e denote the counter electromotive force encountered in each crucible—I compute its value to be e=2.82, with a possibility that it may be less at the actual temperature of reduction. Let T denote the time that the current is active in the production of W pounds of aluminium. Then $W = q\,N\,C\,T$, also the power P, exerted by the engine, will be denoted thus: $P = p\,V\,C$ and the latter divided by the former will be thus expressed: $P \div W = p\,V\,C \div q\,N\,C\,T$; now, cancelling C from both numerator and denominator, we get $P \div W = p\,V \div q\,N\,T$, and if T be unity, and if for $p \div q$ we substitute their value .0015 ÷ .00114 = 1.315, we get $P \div W = 1.315 \times V \div N$. Now, substitute for V its value in terms of $C\,B\,R\,N$ and e and we get $P \div W = 1.315 \times (C\,B + C\,N\,R + N\,e) = 1.315 \times (C\,B \div N + C\,R + e)$, which shows that the power per pound required diminishes as C, B, R, diminish, and as N increases, e remaining constant all the while, being fixed by the laws of chemical action.

If we allow $\frac{\$0.05}{22}$ as the cost of one horse-power, according to Mr. Hunt's estimate, given at Boston, and if we allow $0.06 to be the cost of the ore required to produce one pound of aluminium, allow also $0.01 for the cost of the chemicals used in purifying it and preparing it for the crucibles; allow $0.02 for the cost of carbon anodes consumed per pound of aluminium produced; allow, also, $0.06 for labor, superintendence, depreciation, interest, etc., substituting our estimate of possibly five horse-power per pound of aluminium per hour, we get its total possible future cost per pound down to less than $0.17 per pound, or to less than $340 per ton, and if it be sold at $0.25 per pound, or $500 per ton, an establishment which could turn out only ten tons daily would be in the receipt of a daily profit of $1,600, or a yearly income exceeding $480,000, which would surely pay good interest on quite a large capital; what, then, would be its profits were it to charge $1.50 per pound, as the Pittsburgh Reduction Company charges at the present date of writing? But I must leave this interesting discussion for abler hands than mine.

Discussion on Prof. George S. Moler's Paper on "An Alternate Current Potentiometer."

Professor Thomson: As to the degree of accuracy attainable in this way, if I remember correctly, some tests were undertaken some two or three years ago by us to determine how much variation was possible in a lamp; that is, if you should drop or raise the voltage what was the smallest increase or decrease of voltage suddenly brought on that would show in a lamp, and I think it was about one-tenth of a volt. It could be detected by watching the lamp very closely—simply putting in a resistance and slipping it in and out quickly. We could detect about one-tenth of a volt, which, of course, would confirm the method.

Mr. Weston: As I understand, the arrangement is that we are to have an incandescent lamp simply as an indicator—that the indicator lamp has to be brought from a normal value by a direct current, and then you are to pass an alternating current of unknown electromotive force through it. Is that the proposition?

Professor Nichols: Yes.

Mr. Weston: And determine the electromotive force in this way? I can say that that will work very nicely indeed. We have used that method in endeavoring to arrive at a somewhat difficult problem in connection with an alternating current instrument of great sensibility and portability. I think the method was used about three years ago. The accuracy is greater, the greater the change, of course, in the electromotive force of current flowing through it. The method is undoubtedly susceptible of very close results, indeed.

Professor Nichols: I think that it will be found that there is a limit to the brilliancy of the lamp which you can use in practice, on account of the eye. If you have too bright a light the eye is not susceptible to small changes. Probably there is a maximum brightness which should be used, in order to give the maximum sensitiveness of the method. The change of the lamp will, of course, increase as you increase the intensity of the lamp. If you go to a point where the lamp dazzles the eye, the eye by its decreasing sensitiveness will overcome this. Our experiments thus far go only to confirm Mr. Weston's statement that the lamp should be burned at quite a high temperature.

Prof. George Forbes: I would suggest that there is a very simple way of enormously increasing the sensitiveness of this method. As I understand it, the way in which you use it at present is to look at the lamp while the continuous current is serving it, and then switch it over to the alternating current, and then judge which is the brightest, moving it rapidly back and forward. It seems to me that that method would be enormously more sensitive if you applied two lamps, and used them in a properly constructed photometer with a switch arrangement, which enables you to connect either of them with the alternating or continuous current. Thus you would adjust the potential of the continuous current until you got very near equality, but you would find that one of the lamps was always a little brighter than the other, owing to the sensibility of the lamp. You would then alter the distance of the lamps from the photometric screen slightly, so that on reversing the current you would get an absolute equality, and then you would be able to arrive at a much closer comparison, and it would not matter if there was a very slight difference in the illuminating power of the two lamps with different voltages. I feel perfectly sure that this would increase the sensitiveness of the method about ten-fold.

OBITUARY.

The many friends of Mr. C. E. McCluer, the well-known telephone man of Richmond, Va., will hear with regret of the death of his wife, which occurred two weeks ago at his Richmond home. Mrs. McCluer was highly esteemed by all who knew her, and is sincerely mourned by a large circle of friends.

KINDRED INTERESTS

The Stirling Company, Pullman Building, Chicago, have issued a handsome catalogue, describing the Stirling water tube safety boilers.

Young & Sons, 43 North Seventh street, Philadelphia, inventors and introducers of the American engineers' transit, have sent out a neat catalogue of engineering instruments.

The New York & Ohio Company, Warren, Ohio, makers of the Packard incandescent lamp, have been compelled to enlarge their plant. A 30×60 addition is now being built.

Merchant & Company, the well known Philadelphia jobbers in brass and copper, recently closed a number of large contracts for copper wire with leading telephone companies.

The Electrical Supply Company, 171 Randolph street, Chicago, are making a "Shield Brand" insulating tape, for which they find a considerable demand. It is a namesake of their well known "Shield Brand" wires.

The Bain Break Insulator, handled by the Central Electric Company, Chicago, is having a ready sale, and is fast growing in popularity with electric railroad men, who use it for insulating span wires. The electric light companies are also ordering them in considerable quantities to insulate suspended arc lamps.

A Large Manufacturer of steam, hydraulic and hand elevators in Baltimore, writes that he has been using Dixon's Graphite grease on his elevators for about two years and finds it superior to any lubricant he has ever used. He also uses it on his wire cables to prevent rust and for the guides of elevators. It is made by the Jos. Dixon Crucible Company, of Jersey City, N. J.

Engineering Equipment Company.—On June 1st, Mr. W. F. D. Crane, M. E., became associated with the Engineering Equipment Company, of No. 143 Liberty street, New York. Mr. Crane will give his time principally to the continued development of the company's growing business in the Anderson trolleys, line materials, etc., the Kellogg combination steel center and side poles and other equipment materials for electric railways and engineering works in general.

One of the Important Events in recent electrical history was the opening of a Western office at Chicago, Ill., by the Electrical Construction and Supply Company, perhaps more familiarly known as the "Ward" arc lamp concern. The management of the Western office is entrusted to Messrs. McDougall & Cummings, and they will be found in the Phœnix Building, Chicago, Ill. If the Western management is one half as aggressive as the Eastern, we predict a large success for this new Western venture. It should not be difficult in the wide awake West to dispose of so good an article as the Ward arc lamp.

Berlin Iron Bridge Company.—The Companhia de Focjas e Estaleiros, of Rio de Janeiro, Brazil, have placed the order for a large iron building to be used in connection with their ship building plant with the Berlin Iron Bridge Company, of East Berlin, Conn. The building will be entirely of iron, 165 feet wide by 300 feet long, and will be shipped by steamer from this country, the parts being carefully marked so that it can be erected in place by native workmen at Rio de Janeiro. The Berlin Iron Bridge Company are doing a large trade with the South American Republics, arising from the recent closer commercial relations.

The Ball Engine Company, Erie, Pa., have received the following:

COLUMBUS, O., U. S. A., April 28, 1891.

THE BALL ENGINE CO., Erie, Pa.,

Gentlemen: Replying to your inquiry regarding the work performed by your engines lately purchased by us:

We have two of your 13x12 inch automatic engines at the Helvetia Mines, Helvetia, Clearfield Co., Pa. These engines are running two of our 80 horse-power dynamos, generating power for transmission into the mines for the purpose of running our Jeffrey electric coal mining machines. The duty these engines are called upon to perform is very severe; perhaps more so than street railway work, for the reason that the load is thrown off and on by the short run of each engine and consequent sudden stop. We require a regulation for our work that shall not exceed a loss in revolutions of two per cent. The Ball engines at the above mines have been running about four weeks and are giving entire satisfaction. They are noticed for their beautiful and solid construction and the quietness and steadiness with which they run. Yours truly,

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Planers, 16 in. x 16 in. x 3 ft.; 20 in. x 20 in. x 4 ft.; 24 in. x 24 in. x 6 ft.; 30 in. x 30 in. x 6 ft.; 36 in. x 36 in. x 10 ft.; 42 in. x 42 in. x 12 ft.; 72 in. x 60 in. x 15 ft.; 72 in. x 60 in. x 20 ft.

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Presses, Nos. 51, 52, 53, Ferracute, Nos. 1, 2, 3, Stiles & Parker.

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ELECTRICAL PATENTS

INDEX OF INVENTIONS FOR WHICH LETTERS PATENTS OF THE UNITED STATES WERE ISSUED ON JUNE 2, 1891.

453,187 Glass globe for illuminating purposes; Edward Hobbs, Salem, Mass.

453,216 Electric street car motor; Jabea F. Shawhan, Dayton, O., assignor, by mesne assignments, to Freeman B. Dickerman, Detroit, Mich.

453,225 Electric connector; Frank Wheeler, Meriden, Conn.

453,242 Magneto-electric machine; William Humans, Cambridge, Mass., assignor to the American Magnetic Electric Co., Jersey City, N. J.

453,248 Bracket for electric lamps; Thomas C. Smith, Philadelphia, Pa.

453,260 Electro-magnetic engine; Chas. E. Kells, Jr., New Orleans, La.

453,261 Telegraph receiver; Chas. Langdon Davies, London, England, assignor to Phonopore Syndicate, Limited, of London.

453,281 Safety device for dynamos; Chas. Young, New York City.

453,286 Pole for electric wires; Chas. A. Lieb, New York City.

453,287 Automatic switch for electric motors; Roderich Macrae, Baltimore, Md., assignor to Donaldson-Macrae Electric Co., of Baltimore.

453,319 453,320 Automatic starting switch for electric motors; Ferdinand A. Wessel, Brooklyn, assignor to the Excelsior Electric Co., New York.

453,323 Electric current tester; Wm. H. Ebert, New York, assignor of one-half to John C. Beekman.

453,326 Insulating cover for trolley or conducting wires for electric railways; Albert L. Ide, Springfield, Ill.

453,333 Method of operating motors; Robert R. Zell, Baltimore, Md.

453,349 Switchboard for electric arc light stations; Robert F. Sawyer, Chicago, Ill.

453,355 Process of coating metals with oxides; Alex. E. Haswell and Arthur T. Haswell, Vienna, Austria-Hungary.

453,367 Starting switch for electric motors; Clark C. Haskins, Chicago, Ill.

453,416 Electric annunciator system; Louis M. Pinolet, Brooklyn, N. Y.

453,430 Electrical typewriting machine; James F. McLaughlin, Philadelphia, Pa.

453,433 Holder for telephone receivers; Frank L. Tinning and Wm. K. S. Tinning, Toronto, Ontario, Canada, assignor of one-fifth to Chas. Warren Irwin, of Toronto.

453,455 Electric lamp socket; Le Roy S. White, Waterbury, Conn., assignor to Electrical Appliance Manufacturing Co., of Waterbury.

453,476 Electrical apparatus for surgical purposes; Cornelius B. Harness, London, England.

453,483 Telephone circuit; Wm. W. Jacques, Newton, assignor to American Bell Telephone Co., Boston, Mass.

453,484 Electrical register for measuring pumps; Robt. Jewell, London, England.

453,572 Automatic electric switch; Robt. Baumann, St. Louis, Mo., assignor to Electric Alarm Lock Co., St. Louis.

453,578 Electric railroad signal alarm; Newton S. Chapman, Kansas City, Mo.

453,581 Telephone transmitter; Philip Fitzsimons, Birmingham, Ala., assignor of one-half to Frederick Hardy.

453,583 Electric arc lamp; Wm. Hochhausen, Brooklyn, assignor to Excelsior Electric Co., New York.

453,597 System of electrical distribution; Frederick A. La Roche, Philadelphia, Pa., assignor to La Roche Electric Works.

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